(Courtesy of M. P. A. Lemoisne)

René-Antoine Ferchault de Réaumur from an engraving by Simonneaux
in the Bibliothèque Nationale of Paris

The Natural History of Ants

FROM AN

Unpublished Manuscript in the Archives

OF THE

Academy of Sciences of Paris

BY

René Antoine Ferchault de Réaumur

Translated and Annotated

BY

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TO THE

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OF

ENTOMOLOGISTS

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COIMBATORE

PREFACE

During the spring of 1925, while I was acting as exchange professor at the University of Paris, Professor E. L. Bouvier, the eminent entomologist and president of the Academy of Sciences, kindly permitted me to consult the unpublished manuscripts of Réaumur in the archives of the Institut. Among the latter I found an important and interesting mémoire on ants, which had not been noticed since 1860, when, as I have since ascertained, Flourens called attention to its existence and published a few of its paragraphs. At my request Professor Bouvier secured the services of M. Convers in making an accurate copy of the article, of a number of scattered notes, also by Réaumur, and of a letter by Lyonet on the same subject. The transcription was a matter of no little difficulty because Réaumur's pages were so full of corrections, erasures, archaisms, orthographical errors, etc., that many of them seemed to be quite indecipherable. Fortunately M. Convers' patience, sagacity and knowledge of entomological terminology proved equal to the task. When the transcription was completed Professor Bouvier carefully compared it word for word with the original and forwarded it to me with permission to publish. In presenting it herewith I have adhered closely to the original copy.

In order to place Réaumur's observations in proper historical perspective, it seemed advisable to append a number of annotations, both on the authors whom he consulted and on the observations which he made. The scientific reader may, perhaps, complain that in this portion of the volume my great interest in the subject has led me to indulge in far too much dead erudition. There is, however, some justification for my procedure on the ground that the ants are, so to speak, privileged insects. They are so abundant everywhere and have always aroused so much interest on account

of their peculiar social behaviour, that they have played an important rôle in the folk-lore as well as in the rudimental zoölogical science of all peoples. The more or less mythical views of early observers and writers in regard to them may, therefore, interest the ethnologist and archæologist even when they have little or no interest for the biologist. In the essay on Réaumur's life and work I have endeavoured to reinstate him as the greatest and from our present point of view the most modern-minded naturalist of the eighteenth century. This essay is frankly addressed to our young entomologists in the hope that some of them may be persuaded to undertake a more searching inquiry into Réaumur's life, labours and influence. Of course, such a quest will have to be pursued in France and will involve a scrutiny of unpublished documents belonging to the first half of the eighteenth century. I have appended to the annotations a full bibliography of Réaumur's writings, because its mere perusal gives a more satisfactory picture of the extraordinary range of his investigations than any of his biographies.

I am indebted to my friend, Dr. E. B. Holt, for carefully reading my translation of the *Histoire des Fourmis* and suggesting many improvements in diction. To my friends Professor Bouvier and Professor Maurice Caullery I am under lasting obligations for the interest they have shown and the assistance they have given me, in connection with my study of Réaumur and my other occupations in Paris.

I wish also to thank Dr. George Sarton, lecturer in the History of Science at Harvard University, for certain bibliographical references, and M. P. A. Lemoisne, director of the Cabinet des Estampes, for his kindness in sending me the photograph of Simonneaux' likeness of Réaumur in the Bibliothèque Nationale for use as the frontispiece of the volume.

W. M. Wheeler

Bussey Institution,
Forest Hills, Boston, Massachusetts,
December 31st, 1925.

CONTENTS

	PAGE
Introduction	xi
The Life and Work of Réaumur	3
Original Text of the *Histoire des Fourmis*	43
Translation of the Same	131
Annotations	221
A List of Réaumur's Works	263
Index	275

ILLUSTRATIONS

The youthful Réaumur	*Frontispiece*
Facsimile of Réaumur's handwriting and autograph	page xvi
Facsimile of a page from Réaumur's Journal	47
Réaumur advanced in years	132

INTRODUCTION

COIMBATORE

It has long been known that Réaumur's *Mémoires pour servir à l'Histoire des Insectes* were to have comprised ten quarto volumes, but that only six of them were published. It has not been possible to conjecture what would have been the precise contents of the concluding volumes, because the term "insect," as employed by Réaumur and his contemporaries, applies to many groups of invertebrate animals, such as the spiders, crustaceans, worms and polyps, which are now regarded as distinct classes. According to Cuvier (see p. 11), "the manuscript of the seventh volume, bequeathed at the author's death to the Academy of Sciences, was in such disorder and so incomplete as to be unfit for publication. In it Réaumer had intended to speak of crickets and grasshoppers, while the beetles were to have occupied the eighth and following volumes." But from Lyonet's letter to Réaumur, here published for the first time, it appears that the former understood — probably from previous correspondence with Réaumur — that the seventh volume was to include the ants and beetles. In fact, an examination of the published volumes shows that the seventh volume would most naturally begin with at least one mémoire on the ants and conclude with several on the beetles. The Orthoptera would naturally follow in the eighth, and the two concluding volumes were, perhaps, to be devoted to the spiders, crustaceans, centipedes and worms.

Similar uncertainty prevails in regard to the nature of the Réaumur manuscripts preserved in the archives of the Academy of Sciences. Percheron merely says: "The seventh volume remains in manuscript."* Hagen† quotes Boddaert as saying that "the manuscript and nearly all the

* *Bibliographie Entomologique*, 2 vols. 1837, vol. 2, p. 6.

† *Bibliotheca Entomologica*, 2 vols. 1862, vol. 2, p. 64.

copper plates of Tome VII were completed," and Quérard* states that the Institut still possesses of Tome VII only a few plates and the pertinent text in scattered notes. I find also two other statements in the literature in regard to this matter. De Lignac, a friend and neighbour of Réaumur, in his *Lettres à un Amériquain*, Vol. IV, 1751, says that he knew that the *Histoire des Fourmis* had been completed. Much more valuable information, however, is given by Flourens,† who was interested in the theory of instinct and therefore consulted Réaumur's manuscripts for light on this subject. He says: "I wished to peruse the last pages written by Réaumur. Matters are not altogether as they have been represented by Cuvier. In the first place, there is nothing, or almost nothing — that is, at most a dozen very imperfect pages — on the grasshoppers. There are instead, however, *six mémoires, all complete except the sixth, on the beetles.* I pounced on these six mémoires, hoping that I might find in them some of those histories which the great historiographer of the insects so admirably related touching their instincts, habits and singular aptitudes. All my pains were in vain. The six mémoires which I have mentioned treat only of the external features of the beetles, the classes to which they may be assigned, the transformations of the larvæ into pupæ, of the pupæ into adult insects, and I read in the introduction to the fourth mémoire: 'The care displayed by several female beetles in depositing their eggs in suitable places where they will be well protected till the small larva contained in each is ready to hatch, is not the least interesting of the facts they have to teach us, but we have not yet reached the mémoire in which we propose to describe the industrial procedures to which they are led by their tender solicitude.' Leaving, therefore, the manuscript on the beetles, I passed to others, for there are many of them. There are the corrected manuscript pages, in more or less disorder, of the greater portion of Réaumur's published works.

* *La France littéraire*, vol 7, 1835, p. 481.

† "De quelques fragments inédits de l'histoire des insectes de Réaumur," *Journ. des Savants*, 1860, pp. 137–149, 265–277.

But this was not what I sought. I was seeking some work that had remained unpublished and might be worth wresting from oblivion. At last I found one, and one most opportunely on the very subject with which I am here concerned, namely the *history of insects*. The manuscript of which I wish to speak is entitled *Histoire des Fourmis*. We know that Réaumur, who had written a history of the bees, published nothing on the history of the ants. To be sure, both the bees and the ants have had more recent historians than Réaumur, who have far outstripped him in their observations. Yet his history of the bees will always be read, and if the fragment of the history of the ants, to which I call attention, is ever published, it, too, will be read." Flourens then quotes from the manuscript, but as he was not familiar with the details of myrmecology, the few passages he selected are by no means the most important or the most interesting.

The manuscripts which M. Dorveaux, the archivist of the Institut, kindly placed before me for my inspection in April 1925 were in four large pasteboard boxes. Three of them held materials on the vertebrates, mostly on the birds and on miscellaneous subjects. The fourth box contained the manuscripts on insects, comprising, in addition to an unpublished paper entitled *Les moyens de défendre les oiseaux désséchés contre les insectes*, a considerable number of notes, with drawings of beetles, ticks, mites, moths, grasshoppers, etc., and a folder marked *Fourmis* containing large wide-margined, foolscap sheets numbered consecutively from 79 to 157. Pages 79 to 148 are the manuscript described by Flourens and bear the title *Histoire des Fourmis*, but pages 149 to 157 consist of a number of detached notes on ants, some of them with special heads. There is in the same folder a letter from Lyonet, in a beautiful hand, written from The Hague, December 5, 1743. I could find no drawings of ants. All the material in the folder, carefully transcribed by M. Convers and revised and compared with the original by Professor Bouvier, is reproduced, with close attention to orthography and punctuation, in the present volume. Since Réaumur began each of the published volumes with a long

preface containing a summary discussion of the forms described in its various articles, or mémoires, it is probable that 78 pages were allowed for the preface to Tome VII, and that the *Histoire des Fourmis* was to be its first mémoire. I found no traces of this preface, which he probably intended to write after the completion of the remainder of the volume.

The *Histoire des Fourmis* bears no date, but I believe that the time of its composition may be ascertained with sufficient accuracy from indications in the text. In one place, Réaumur shows very clearly that he is writing at a time when Cardinal de Fleury, the prime minister of Louis XV, was suffering from an illness so critical that "all nations unite their prayers with those of the French for the lengthening of his days." This must refer to the last illness of the cardinal, when he was in his dotage and had involved France in the war of the Austrian accession. Now d'Argenson * says under date of October 23, 1742 (Vol. II, p. 260) that "the cardinal is very weak, grows thinner day by day and has only a breath of life left," and under date of January 30th, 1743, "at last the cardinal de Fleury died at noon yesterday." The *Histoire* was therefore written sometime between the end of October 1742 and the end of January 1743. That it could not have been composed later is shown by some of the dated notes, which were made during the summer months of 1743 and contain observations of facts unknown to Réaumur while he was working on the *Histoire*.

Réaumur wrote in a bold hand, with little attention to punctuation. The accents are mostly omitted, capital letters are rarely employed, even in proper names, and there are many mistakes in orthography and not a few in grammar. Like some modern writers, he probably preferred to make editors and printers responsible for such linguistic minutiæ. The handwriting in the accompanying autograph, in the author's possession, in which he acknowledges the receipt from M. Couplée, treasurer of the Academy, of some of the plates and vignettes engraved by Haussard for the fifth volume of

* *Mémoires et Journal inédits du marquis d'Argenson, ministre des affaires etrangères sous Louis XV*, 5 vols., Paris, P. Jannet, 1857–1858.

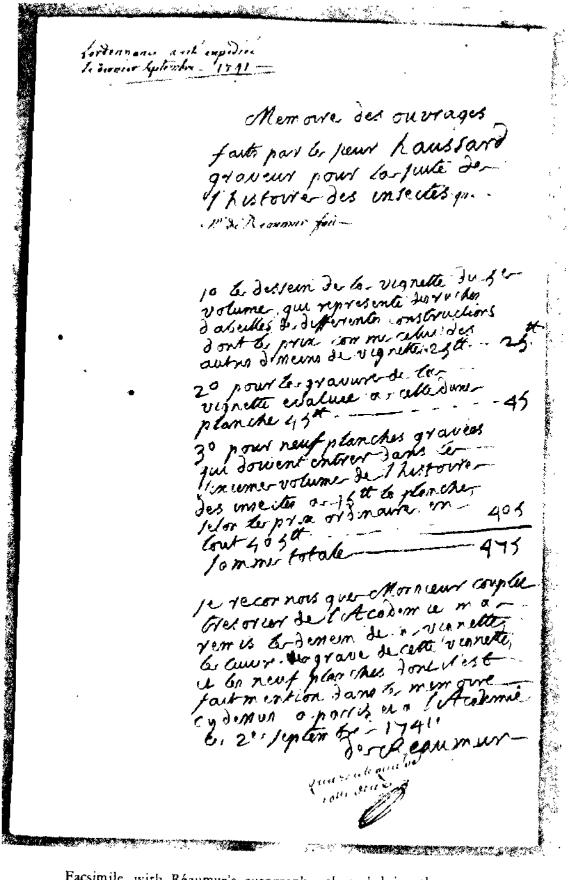
the *Mémoires*, is merely somewhat bolder, clearer and more carefully executed than that of the *Histoire des Fourmis*, written two years later, in his sixtieth year. (See facsimile opposite p. xvi)

Attention has often been called to the peculiarities of Réaumur's style. It has always been described as clear and pleasing, and some have greatly admired his extraordinary powers of description. There are not a few passages in the *Histoire* and the "Notes" which will strike the reader as fine examples of this excellent quality. But a number of more modern authors have complained of his prolixity. Miall,* however, finds that he "writes in a fluent and animated style. He does not disdain personal incidents, illustrations from every-day life, nor anything which may kindle the reader's interest. Some have called him diffuse, but his supposed diffuseness is only the leisurely manner of a writer who addresses a wide circle of readers. He is never in a hurry, never enters into dry and technical discussions, never wastes his reader's time. His speculations, even when antiquated, are worth the attention of those who would enter into the thoughts of a sagacious and most productive investigator." According to Flourens, "Réaumur's style is pervaded by a gentle, continuous movement, which sustains the interest, a reasonable naïveté, the sincerity of a serious observer, and, if I may presume to say so, in so circumscribed a subject, of an historian who is also an honest man." The slow movement and diffuseness noticed by these and other writers seems to be due to a desire for completeness of description. Hence the introduction of words or whole phrases which we should omit but which seemed to Réaumur essential to the adequate determination of the thought or image which he wished to evoke; hence also the heaping up of relative clauses, the looseness of syntactical construction, the avoidance of concisely periodic sentences and a preference for indirect or negative statements. But all this is characteristic of many other eighteenth-century writers, English and German as well as French, and is the expression

* *The Natural History of Aquatic Insects*, Macmillan & Co. 1895, p. 240.

of a calmer, more leisurely and more refined reaction to the social environment. To us, who are accustomed to twentieth-century styles of writing, which so often have the noisy, precipitate and syncopated qualities of a jazz orchestra, Réaumur's diction seems very restrained, tenuous and almost atonic, like a minuet performed on an old harpsichord. It is, of course, impossible to reproduce the quaint charm of such writing in the English of our day. This might have been accomplished by some one of the British masters of prose among Réaumur's contemporaries, by Addison, Fielding or Goldsmith. It is, perhaps, deplorable that Goldsmith, instead of writing his absurd *Animated Nature*, did not carefully translate the six published volumes of the *Mémoires*.

The *Histoire des Fourmis* is incomplete. Though it contains an account of the structure, development and many of the most interesting habits of ants, the peculiar spraying behavior, which Réaumur must have observed in *Formica pratensis*, is not described. That he had planned to include a consideration of the various methods of destroying ants is indicated by one of the notes (see p. 214). Yet even in its unfinished form, the work must be regarded as the most important myrmecological document of the eighteenth century. This is obvious when we compare it with the only other serious contributions of the time on the same subject, namely those of Swammerdam (1737–1738), Linnæus (1741), William Gould (1747) and De Geer (1777). Swammerdam had not succeeded in completely identifying the castes of ants, since he failed to observe that the fertile females (queens) at first bear wings but later lose them. He correctly interpreted the deälated forms as females, but regarded the same individuals in their winged phase as males. Linnæus had avoided this error and had clearly defined the three castes and homologized them with the three castes of the honey-bee; but Réaumur, ten years previously (1731), had not only determined the castes and their relationships but had made accurate observations on the marriage flight of a common species, *Myrmica rubra* (see p. 165). He also shows in the *Histoire* that isolated deälated queens are able to care



Ordonnance a esté expédiée le dernier Septembre 1741

Memoire des ouvrages faits par le sieur Haussard graveur pour la suite de l'histoire des insectes que Mr de Reaumur fait

1° le dessein de la vignette du 6e volume qui represente diverses ruches d'abeilles & differentes constructions dont le prix comme celui des autres desseins de vignettes 25# ... 25#

2° pour la gravure de la vignette evaluée a celle d'une planche 45# ... 45

3° pour neuf planches gravées qui doivent entrer dans le sixieme volume de l'histoire des insectes a 45# la planche selon le prix ordinaire en tout 405# ... 405

somme totale ... 475

je reconnois que Monsieur Couplet tresorier de l'Academie m'a remis le dessein de la vignette, le cuivre gravé de cette vignette, et les neuf planches dont il est fait mention dans ce memoire cy dessus apportés a l'Academie le 2e septembre 1741

Ferchault de Reaumur

Facsimile, with Réaumur's autograph, acknowledging the receipt, Sept. 2, 1741, of several plates and vignettes engraved by Haussard for the fifth and sixth volumes of the *Mémoires pour servir à l'Histoire des Insectes*

for their young, and although he did not adequately elucidate the methods of colony formation, he made more progress toward a solution of this problem than any observer during the next hundred years. He clearly anticipated many of the discoveries of William Gould, whose valuable little volume on British ants was published in 1747. De Geer's fine work, which appeared in 1777, though historically very important as a study of the morphology and classification of ants, adds little to previous knowledge on ant behaviour. The next really great advance in myrmecology was due to Pierre Huber, whose epoch-making book was published in 1810,* but even he can hardly be said to have had a clearer conception of the methods of colony formation than Réaumur. Apart from the light which it sheds on many peculiarities of the ants, the *Histoire* is remarkable for its emphasis on the experimental method. This will, perhaps, startle some readers who have been led to believe that this method is a very recent innovation in behaviouristic investigations. There can be little doubt that had the *Histoire* been completed and published soon after it was written, the study of myrmecology would have been greatly stimulated, and the solution of many of its problems, especially those relating to the founding and development of ant-colonies, would have been greatly accelerated.

In my "Annotations" I have endeavoured to evaluate the more important observations recorded in the *Histoire*. Réaumur's "Notes" are hasty jottings, made for the most part after the writing of the *Histoire*, to which some of them are valuable additions. A few of them are interesting only as showing his preoccupation with the ants for many years prior to 1743 and 1744. The letter from Lyonet is of considerable interest, not only on account of the light it sheds on the personal relations of the two naturalists but as containing information on the proposed contents of the seventh volume of the *Mémoires*. It also proves that Lyonet made a few discoveries which have usually been attributed to Gould and De Geer.

* *Recherches sur les mœurs des fourmis indigènes*, Paris et Genève, 1810.

THE LIFE AND WORK OF RÉAUMUR

THE LIFE AND WORK OF RÉAUMUR

Zoölogists of the present day find the study of the animal world so vast, intricate and absorbing and so dependent on elaborate and time-consuming methods of investigation that, like most scientists, they take little or no interest in the history of more than the past few decades of their specialties. Even the systematists rarely pursue their inquiries as far back as Linnæus, and then only for the purpose of settling disputes concerning priority of nomenclature. Yet we can scarcely blame scientists for this lack of historical interest. The very habit of impersonal estimation, which every investigator endeavours to cultivate, naturally leads him to eliminate from the history of his subject the personalities of even its great pioneers and to reduce them to mere names and dates and the barest mention of their most eminent achievements. To the recognition of this tendency to depersonalization we may add the rather obvious consideration that the lives of scientists are for the most part very drab, that they are rarely admitted or care to be admitted to the ostentatious environment of the worldly great, and that their most vivid emotional experiences, when not of joy in invention or discovery, arise out of their quarrels over facts, hypotheses and priority and their intrigues for professional prestige and advancement — all of which necessarily lose their interest, the quarrels with the eventual triumph of the truth and the intrigues with the death in no long time of the intriguers. Then, too, the bodily appetites of the scientist, unlike those of the artist, are, as a rule so normal or so subnormal that neither posterity nor his contemporaries can find anything to excite their interest in his amatory behaviour. Hence the progressive disregard of the very persons who, within three centuries, have brought about a revolution in our thinking and activities so amaz-

ing that the previous development of our race, through thousands of centuries of post-Pliocene time, seems not unlike the monotonous stability of some animal species.

Nowhere is this lack of historical and biographical interest more noticeable than among entomologists, who necessarily suffer more than any other zoölogists from their inability to frame an adequate synthesis of the prodigious number of insect species and of their activities, for, as Michelet says, "leur nom, c'est l'infini vivant." Not only do the personalities of the great entomologists of the past tend to fade into oblivion, but the records of their discoveries, apart from those in the field of taxonomy, are mostly forgotten and their abiding influence on the investigators of our time is no longer perceived. Their writings are neglected, not because they are now unreadable, for they are certainly no duller than the works of our present-day entomologists, but because specialization has become so intense that half a lifetime of patient and incessant study barely enables one to gain sufficient proficiency to investigate a single order or family of insects with intelligence and profit.

Although a too constant preoccupation with historical details might tend to inhibit rather than to advance entomology, there are at least two reasons why a more intimate acquaintance with the lives, works and influence of the great pioneers of the science is eminently desirable. First, these pioneers are a permanent source of encouragement and inspiration. Can any entomologist, who meditates on the deeply pathetic lives of such indomitable investigators as Swammerdam and Fabre, fail to take heart and pursue with renewed zest the studies which in moments of depression seem so trivial and so exhausting in comparison with many other pursuits? And second, how can we hope to estimate our own efforts and those of our contemporaries in complete detachment from the achievements of former centuries?

Whether we know it or not, we are still following in the footsteps of the leading entomologists of the past. And among these leaders the greatest, I am convinced, is Réaumur, for of all the early investigators he combined the most

comprehensive vision with the keenest powers of observation and the clearest conception of the importance, both theoretical and practical, of the study of insects. That I am not alone in this high estimation is shown by one of Huxley's letters * in which he is comparing Réaumur and Darwin. He says: "From the time of Aristotle to the present day I know of but one man who has shown himself Mr. Darwin's equal in one field of research — and that is Réaumur. In the breadth and range of Mr. Darwin's investigations upon the works of animals and plants, in the minute patient accuracy of his observations and in the philosophical ideas which have guided them, I know of no one who is to be placed in the same rank with him except Réaumur."

Réaumur's attainments stand out in boldest relief when we study him in connection with his predecessors and contemporaries, who must here be referred to with the greatest brevity. It is well known that the general scientific program to which we still adhere, though many believe it to be now in course of transformation as a result of the relativity theory, was established by the great thinkers and investigators of the seventeenth century — Galilei, Descartes, Newton and Leibnitz. Although their attention was largely confined to the domains of physics and mathematics, their extraordinary success as interpreters of nature could not fail to influence and stimulate the great biologists of their time: Harvey (1578–1657), Malpighi (1628–1694), Redi (1626–1697), Vallisnieri (1661–1730), Hooke (1635–1703), Ray (1628–1705(?)), Swammerdam (1637–1680) and Leeuwenhoek (1632–1703). But the difficulty of applying experimental and mathematical methods to the study of organisms, and the deplorably rudimental state in which, since Aristotle, knowledge concerning them had been permitted to languish, led these men to turn their attention largely to the field of descriptive morphology, though some rather simple experimentation was attempted, especially by Redi. By the following century the number of workers and the knowledge of organisms had so greatly increased that we

* L. Huxley, *Life and Letters of Thomas Henry Huxley*, vol. 1, 1902, p. 515.

find the leading departments of biology, and therefore also of entomology, established, and extraordinary specialists ardently busied with their development. Lyonet (1707–1789) devotes a long life to purely morphological studies; Spallanzani (1729–1799), Trembley (1710–1784), Bonnet (1720–1793) and later François Huber (1777–1840) to physiology and experimental ethology; Linnæus (1707–1778), Fabricius (1745–1808), and Latreille (1762–1833) to classification. But Réaumur stands out conspicuously as the most comprehensive mind of the period, combining remarkable achievement in entomology with an extraordinary and fruitful industry in many other sciences — mathematics, physics, metallurgy, crystallography, meteorology, forestry and economic biology generally.

His name and titles were: René-Antoine Ferchault, Écuyer; Seigneur de Réaumur, des Angles et de la Bermondière; commander and intendant of the Royal Military Order of Saint Louis; member of the Royal Society of Great Britain, of the Academies of Sciences of France, Prussia, Russia and Sweden and of the Institute of Bologna. The most important sources for his biography are the éloge delivered by the astronomer and poet Grandjean de Fouchy at the session of April 5, 1758, of the Paris Academy of Sciences,* an article by Cuvier in the *Biographie Universelle*, vol. 37, 1824, derived in great part from the éloge, and an important collection of Réaumur's letters which have been overlooked by all his biographers.† Miall‡ has translated the more important portions of Cuvier's article with some comments of his own [in brackets]. It seems advisable to

* See *l'Histoire de l'Acad. Sc. Paris*, *1757* (*1762*), p. 201–216.

† These letters, fifty-five in number and covering the period from April 1743 to March 1757, were edited by G. Musset and published with a biographical introduction in the *Annales de la Société des Sciences Naturelles* of the Académie des Belles-Lettres, Sciences et Arts of La Rochelle, vol. 21, 1884, p. 177–258, and vol. 22, 1885, p. 89–191. They were reprinted as a small volume of 183 pages in 1886. Thirty-four of them are addressed to the naturalist Jean François Séguier, the remainder in great part to the physicist Jean Baptiste Ludot (1703–1771) and the eminent physiologist Albrecht von Haller (1708–1777). The volume also contains an inventory of the furniture of Réaumur's chateaux. This is interesting as showing the unostentatious mode of life of a learned French nobleman in the eighteenth century.

‡ *The Early Naturalists, their Lives and Work* (*1530–1789*), London, Macmillan & Co., 1912, p. 244.

quote this, because it would be very difficult to give a more concise sketch of Réaumur's work and because there are, both in Cuvier's and in Miall's accounts, certain statements which I wish to consider in the sequel:

"Réaumur, one of the most ingenious naturalists and physicists that France has produced, was born at La Rochelle in 1683. He was the son of a judge of appeal in that city. After beginning his education in his native place, he went on to the Jesuits at Poitiers, and afterwards studied law at Bourges. A propensity to observe nature then took possession of him, and ample means enabled him to pursue this taste with youthful eagerness. He laid a foundation for his future career in the serious study of mathematics, and when he felt himself prepared to try his strength with professed naturalists and physicists, betook himself to Paris. This was in 1703, when he was not yet twenty years old. President Hénault, a relative, made him known to men of science, and in 1708, being then twenty-four and having already contributed some geometrical papers to the Academy of Sciences, he was admitted to that learned body.

"For nearly fifty years Réaumur was one of the most active and useful members; his labours dealt with industrial arts, general physics, and natural history successively, and hardly a year passed in which he did not publish some memoirs of great importance or interest. He was early pledged to co-operate in a description of the mechanical arts, which the Academy had undertaken. Not confining himself to a mere record of the state of the various industries, he sought to improve them by fresh applications of scientific principles, while at the same time he enlarged our knowledge of natural phenomena by his industrial experience. In his account of rope-making (1711), he proved by conclusive experiments that, contrary to the prevalent opinion, torsion diminishes the strength of cords. In 1713, when engaged upon a description of gold wire-drawing, he demonstrated the extraordinary ductility of certain metals. In 1715 the investigation of the colours of false pearls made him acquainted with the singular substance which gives a

lustre to the scales of fishes, and this led him to study the development and growth of the scales themselves. These inquiries became linked to researches which he had carried on ever since 1709, into the formation and growth of the shells of mollusks, which he showed not to arise by intussusception [for incorporation of new matter with every part of a pre-existing structure; Réaumur maintained that the shell grows by the addition of layers]. In 1717 he attended to pearl-formation, and sought to compel bivalves to produce pearls. When he had occasion, in 1715, to describe the turquoise mines of the south of France, and the methods in use for producing the blue colour, he discovered that turquoises are the teeth of the large [extinct] animal, since described under the name of mastodon [this is true only of the so-called occidental turquoise, which forms on teeth and bones after long burial in the ground]. But his most important researches in technical science were those upon iron and steel, published as a separate work in 1722 under the title *Traité sur l'art de convertir le fer en acier, et d'adoucir le fer fondu.* Our forges were then almost in their infancy, and we made no steel; all that was required in the arts was brought to us from abroad. It was only by innumerable experiments that Réaumur came to discover the art of steel-making. The Duke of Orleans, then Regent of France, proposed to remunerate him for his service by a pension of twelve thousand livres. At this date no tinplate was made in France; all came to us from Germany; Réaumur succeeded in making it by a cheap method, which he published in 1725. In his numerous experiments he had more than once occasion to remark that cast metals, in cooling, assumed regular forms; and this led him in 1724 to give a first sketch of metallic crystallography. The manufacture of porcelain also interested him; he sent to China for the materials, and busied himself in searching for similar minerals in France. His memoirs on this subject date from 1727 to 1729; his attempts were not entirely successful, but Darcet, and especially Macquer, following the indications given by him, were more fortunate, and succeeded in discovering the fine hard por-

celain which we now employ for so many purposes. Réaumur also devised the hard white glass, still known as Réaumur's porcelain, of which he published an account in 1739. We owe to him the first attempts made to introduce into France the artificial incubation of eggs, practised from time immemorial in Egypt. He showed how to preserve eggs by smearing them with fat, how to hinder the evaporation of spirituous liquors by mercury, and suggested many other processes of greater or less practical utility. He improved the hanging of carriage bodies and the fitting of axles. In 1711 he rediscovered a mollusk which yields a dye answering to the purple of the ancients. He sought to turn to account the silk of spiders,* and it is a singular fact that his memoir on spiders' silk, dated 1710, was translated into the Manchu language at the request of the Emperor of China, who wished to read in his own language a paper whose title had moved his curiosity. In physics Réaumur is best known by his thermometer, which he brought out in 1731. The freezing and boiling-points of water are taken as fixed points, and the interval divided into 80 degrees, that number being chosen on account of the accidental circumstance that the alcohol which he used dilated $\frac{80}{1000}$ of its bulk [on being brought from the freezing-point to the boiling-point of water]; this mode of graduation has since been abandoned in favour of a centesimal division. As the fixed points adopted by Réaumur are still retained, all modern thermometers are in a sense Réaumur thermometers; it must, however, be admitted that the original conception belongs to Newton. In the course of the numerous experiments which this invention involved, Réaumur made curious observations on the increase or diminution of heat produced by the mixing of liquids, and also on freezing mixtures. He collected with great care observations on the temperature of various places as registered by his own thermometer, and gave an active impulse to this branch of meteorology. He observed that a freezing temperature does not prevent the evaporation of snow.

* Spiders' silk proved to be too fine and therefore too costly.

"*In spite of the importance and practical utility of the publications of which we have just given a very brief* account, there was yet more novelty and interest in his natural history memoirs. Besides what he had already written about the scales of fishes, the growth of shells and petrified teeth, he described in 1710 the modes of locomotion of many mollusks, star fishes, and other invertebrate animals. [The first description of the ambulacral feet was given by Réaumur]. In 1712 he made known the singular phenomena relating to the reproduction of cast limbs of crayfishes and lobsters. In 1715 he gave a detailed account of the torpedo shock, and of the organ by which it is produced, but electrical phenomena were then too imperfectly understood to make a thorough explanation possible. He examined several of our rivers, whose sand contains gold, and wrote a memoir on them in 1718. The vast layers of fossil shells, known in Touraine as Faluns, did not escape his notice; he described them in 1720. He investigated in 1723 the light emitted by certain mollusks, and especially by the Pholadidæ. It will be seen that Réaumur was by no means unacquainted with physiology. Experiments as ingenious as they were decisive, showed him in 1752 the singular difference in the digestive organs of birds of prey, whose stomach acts on the food only by means of a solvent liquid, and those of grain-eating birds, in which a very powerful muscular gizzard exerts a pressure sufficiently great to crush and pulverise extremely hard substances."

"[Réaumur's experiments *on the digestion of birds, are memorable in the history of physiology. Seeking to clear* up the question whether food in the stomach is merely triturated, or whether it undergoes a chemical change, and in that case whether the change most resembles solution or putrefaction, he made a number of ingenious experiments on a captive kite. Small metal tubes, whose ends were closed by fine gratings, were filled with pieces of meat and offered to the bird in its food. When the kite, according to custom, rejected the tubes with other indigestible matter, the contents were carefully examined. The meat, though protected

against trituration, was found to be partly dissolved; it exhibited no signs of putrefactive change. Even fragments of bone were more or less corroded. Vegetable matter on the other hand was hardly acted on. The tubes contained besides the remains of food a yellow fluid of bitter taste; large quantities of this were collected by tubes filled with pieces of sponge, which could be squeezed after rejection from the stomach. With this fluid Réaumur attempted artificial digestion, and though complete success was not achieved he was at least able to show that gastric digestion differs altogether from putrefactive change. When his kite died, Réaumur carried on the experiments with dogs and sheep. These results were not forgotten, and Réaumur's method became still more productive in the hands of Spallanzani.]

"But of all the works of Réaumur, the most remarkable are the *Mémoires pour servir a l'Histoire des Insectes*, of which six quarto volumes were issued between 1734 and 1742. This history can never cease to be studied with the keenest interest by those who would frame an exact notion of nature, and of the marvellous variety of means which she employs in the preservation of organisms apparently so frail and easily destroyed. Réaumur displays extraordinary sagacity in observing the special instincts which ensure the safety of these feeble creatures, and keeps our attention alive by a continual succession of new and striking contrivances. His style is somewhat diffuse, but so clear as to render everything plain, and the facts which he relates are rigorously true. The *History of Insects* can be read with all the interest of the most absorbing romance. Unfortunately it remains unfinished; the manuscript of the seventh volume, bequeathed at the author's death to the Academy of Sciences, was in such disorder and so incomplete as to be unfit for publication. In it Réaumur had intended to speak of crickets and grasshoppers, while the beetles were to have occupied the eighth and following volumes. The six volumes which actually appeared treat of the remaining orders of insects. [Cuvier's rapid summary of the *History of Insects* is omitted.]

"'The *History of Insects* had placed Réaumur in the front

rank of naturalists by the time that the first volumes of the *Natural History* of Buffon began to appear. Buffon somewhat eclipsed by the brilliancy of his style the popularity of the elder naturalist. Réaumur seems to have been weak enough to feel some jealousy, and was perhaps concerned in the publication entitled *Letters to an American*, the anonymous production of an Oratorian named Lignac, who lived not far from Réaumur's country seat, and often visited him. In this work Buffon and his associate, Daubenton, were treated contemptuously, while Réaumur, his works, and his collections were highly praised. Réaumur was the first man in France to form tolerably extensive collections of animals. Brisson, his curator, drew from these collections the chief material for his work on quadrupeds, and more particularly for his great *Ornithology*, in six quarto volumes. These specimens, though imperfectly cured, and most of them simply dried, passed into the Royal Cabinet after the death of their first owner, and long constituted the principal part of the bird collection. Many of the coloured plates of Buffon were also drawn from them, which explains the occasional resemblance between Buffon's and Brisson's figures.

"'Réaumur's life passed in tranquillity, part being spent on his estate in Saintonge, part at his country house at Bercy, near Paris. He held no official post, and devoted every moment of his time to science. Public esteem and influence with the government sufficed to gratify his ambition. In order to oblige a relative who had been driven to resign the place of intendant of the order of St. Louis, Réaumur purchased the office, but only assumed the insignia himself, relinquishing the emoluments to his relative. It does not appear that he was ever married. A fall, which he met with in 1757 at the chateau of Bermondière in Maine, where he was spending his vacation, hastened his death. He died on 18th October, 1757, at the age of 74. Besides the numerous memoirs which he contributed to the *Receuil* of the Academy (where also is to be found his *Eloge* by Grandjean de Fouchy) and other published writings, he left behind him 138 portfolios filled with complete or imperfect works

and observations, as well as innumerable other papers. Among them was found a large part of his *History of the Useful Arts*, almost fit for publication besides many memoranda for what still was left unfinished.'

"[During the years 1742–57 Réaumur hardly published anything, and there is no reason to suppose that he wrote much. We are left to conjecture why a life which had been so strenuous should close in comparative inertia, while the concluding volumes of the great *History of Insects* remained unwritten.]"

So little is said in the preceding biography about Réaumur's personality that I quote one of the concluding paragraphs from de Fouchy's eulogy: — "M. de Réaumur's works, which we have indicated, acquaint us sufficiently with the scope and powers of his mind, but another pen is needed to depict the excellence of his heart. A true friend, always ready to seize every opportunity to demonstrate his affection, he neglected none of its manifestations. His influence and the acquaintances it had cost him so much to acquire, were in his estimation merely a treasure on which his friends might draw in case of need. He was so punctual in coming to inquire after their health, when they were ill, that some of them, who felt that they saw too little of him, said they would willingly have the fever merely for the sake of enjoying his attentions more frequently. The blows of fortune that prostrated his friends only strengthened the ties that bound him to them. He was by such sentiments rendered so worthy of their esteem that a list of them would include all the personages of Europe most distinguished by birth and talent. The greatest men vied for the honor of his friendship. If he had any enemies (and what great man can fail to have them?), he was never the aggressor and never opposed them, except with the splendour of his fame and an imperturbable philosophy. Owing to the sweetness of his disposirion he was gladly welcomed in society. He permitted none to feel the superiority of his genius, and while he never sought to instruct, those who left his presence felt that their knowledge had been increased. His habits were

no less pure than his thoughts and, faithful to the duties imposed by religion, his deportment was ever most refined and judicious." *

It is not surprising that a person of such character and attainments should have become a power in the Académie des Sciences even at a time when its membership included an unusual number of brilliant men and when France, in the eyes of the rest of Europe, had attained the pinnacle of the most splendid civilization. Maury † informs us that "Réaumur and Clairaut represented French science in all its effulgence during the first half of the eighteenth century. Clairaut was a mathematical genius, but Réaumur combined, on the other hand, in a high degree all the qualities that were lacking in Clairaut. He aspired to domination and succeeded in wielding it over his confrères. He had entered the Academy when he was very young, only twenty-four years of age. Being of distinguished birth, his manners inspired respect and he took part in the discussions and dissensions, for, far from confining himself exclusively to his own investigations, he manifested an interest in those of others. . . . So much work, so many inventions made Réaumur one of the most important men of the Academy, where the authority of his word settled many a controversy. For more than twenty years his control of the Company was undisputed." But by the second half of the century two other brilliant men, Buffon and D'Alembert, had acquired such an ascendency in the Academy, that Réaumur's prestige was menaced and the dissension mentioned by Cuvier (p. 12) between the two zoölogists, became the more unavoidable because their dispositions and scientific outlook were so very different. If I review this quarrel it is from no desire to indulge in antiquated gossip, but because it seems to me to be highly instructive and may have some significance in connection with Miall's concluding parenthetical remarks.

Apart from certain passages in Buffon's and Réaumur's

* The truth of de Fouchy's estimate of Réaumur's character is amply attested by his correspondence.

† *L'Ancienne Académie des Sciences.* Paris, Libr. Académique, 1864.

works the sources of our information in regard to their falling out are de Lignac's *Letters to an American*, d'Argenson's *Mémoires and Journal*, Cuvier's *Life of Daubenton* and Maury's *History of the Ancient Academy of Sciences*. Maury's account, which I quote, is entertaining: "Buffon conceived the bold project of describing all animals. Réaumur had as yet acquainted us only with the details of the smallest. The former, in his great *History of Nature*, the plan of which was so vast as to be impossible of achievement, gave a prominent place to the mammals and birds, the only animals of which he had some knowledge. Réaumur, who felt his end approaching without even having begun what Buffon, who was still young at that time, promised to accomplish, was exasperated to see eluding his grasp the glory which he had no desire to share with any of his confrères. Jealousy possessed him and, far from facilitating the meritorious and difficult labors of Buffon and Daubenton, he occupied the time of the Academy with his claims and recriminations. Not daring himself to criticize a work which, from its inception, had aroused enthusiasm, he had recourse for purposes of denigration, to the complaisant pen of an Oratorian, the Abbé de Lignac. The priest attacked the *Theory of the Earth* and cast suspicion on the orthodoxy of its author. And in this he was not altogether without good reasons, since we must admit that Moses had been very rarely consulted by Buffon. But being an adroit flatterer of those in power, the great naturalist, who had no desire to get into difficulties with the Sorbonne or with the authorities, was able to shield himself behind the royal protection and escape from the anathema. Réaumur, seeing that his direct assaults were powerless, attacked Daubenton, who was in an inferior position and therefore less to be feared, knowing well, moreover, that by interfering with his work, he would at the same time paralyze his rival, for Buffon could not get on without his collaborator. The great naturalist had to use his influence with Madame de Pompadour to save the innocent Daubenton from the effects of an enmity to which otherwise he would have fallen a victim. Now that Réau-

mur and Buffon are both dead, the wrongs they did each other are forgotten; science blesses both their names and unites them in the common glory which is that of France. Brisson, Réaumur's collaborator, sought in vain to prolong the quarrel. To Buffon's history of the birds, he opposed the one he had prepared under the direction of his master, but Buffon had acquired so much popularity that he had nothing to fear from so puny an adversary. The only man who with advantage could have disputed the crown which all learned Europe bestowed upon him, was Daubenton, but he contented himself with weaving into it the most beautiful flowers. He it was who collected in the Museum the products of the whole of Nature and placed them under the intendant's eyes in order that he might describe them with becoming dignity; it was he who revised Buffon's work, verified on the specimen itself what the latter had written about it, before the description went to the printer, and called his attention to the faulty and hazardous interpretations which he advanced. Buffon thought of Daubenton only as an assistant, 'but,' says Cuvier, 'he found in him more than he had sought, more even than he had thought necessary, and it was probably not in those portions of the work in which Buffon required his help that Daubenton was most useful to him.'"*

It will be noticed that in this account Réaumur is represented as the aggressor, contrary to de Fouchy's statement in the éloge.† Maury seems to have derived most of his mate-

* L. F. A. Maury, *L'Ancienne Académie des Sciences.* Paris, Libr. Académique, 1864, pp. 280, 281.

† Musset (Réaumur's *Lettres*, loc. cit.) discusses the dissension between Réaumur and Buffon as follows: "There was only one man towards whom Réaumur seems not to have displayed the benevolence in which all others shared. This was the illustrious Buffon. Was there merely a difference in genius between these two men, the one excelling in the splendour of his style, the loftiness of his thoughts and a fondness for generalization and synthesis, the other in the minuteness of his observations, the absolute submission to brute fact, the fear of error and abstention from all imaginary conceptions? Or was the rancour due to some occurrence which history or rumour have failed to record? We cannot decide. It is certain that these two minds were sundered by a sullen antipathy, which both manifested on various occasions. It is shown even in the letters. If it is not proved that Réaumur directly collaborated in the work which his friend and neighbour, the Abbé de Lignac, wrote for the purpose of overturning Buffon's theories, these letters show, nevertheless, that Réau-

rial from Cuvier * and d'Argenson,† who in his fifth volume (p. 117) gives the following review of the 1751 edition of de Lignac's work: "The true author is M. de Réaumur, of the same Academy of Sciences as M. de Buffon, a great enemy of the latter, envious and jealous of his works and emoluments. Buffon has been criticized by the devout, because he has not sufficiently respected the physics revealed in Genesis, and is accused of having furnished occasion for the system in the Book *Telliamed*, which denies the deluge. There it is maintained that the earth was originally covered with water, that the most ancient of animals were the fishes, that all the sea-shells, even those of China, which are today found in the interiors of our continents and on mountains, were derived from that original aqueous habitat and not from Noah's deluge, as the devout believe. He must indeed be a very learned and very studious man who would follow him in his sublime mathematical physics. Réaumur attached to himself a little father of the Oratory, who has edited the work. He was careful not to make the whole work revolve about avenged devotion and religion; he censures Buffon on many matters, on his errors, his contradictions and the vanity of a proud and superficial author. As a matter of

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mur became the eager sponsor of the work and employed it in combatting his adversary. But we are loath to admit a feeling of jealousy on Réaumur's part when we stop to consider that there was no basis nor *raison d'être* for such a feeling. Even before Buffon had become a celebrity, when his name was scarcely known, and before he had undertaken the preparation of his great work in collaboration with Daubenton, Réaumur voices his reservations. He who had spent his life and had exercized his patience in observing a certain number of animal species, asks with astonishment how it is possible for Buffon confidently to embrace the whole of nature and all its animals. To be sure, he sometimes asks this question in terms that are rather tart and reveal a certain irritation. But on the other hand, he often criticized other scientists, even some who might have felt resentment, in very different terms. In the whole matter, therefore, there is something that escapes us. And when are we to suppose that this jealousy arose? At the very moment when Réaumur had attained to the most enviable distinction, a dominant influence in the Academy, a universal celebrity, a pension of 12,000 livres which, with the consent of his sovereign, he generously turned over to the Academy of Sciences, since the expenses of his own collection for the purchase and preservation of birds, were, as he himself tells us in his letters to Séguier, paid from the King's treasury."

* Notice sur la vie et les ouvrages du citoyen Daubenton. *Mém. de l'Inst. Nat. Sciences et Arts*. Paris, Baudouin, 1801, p. 81.

† *Mémoires et journal inédit du marquis d'Argenson, ministre des affaires étrangères sous Louis XV*, 5 vols. Paris, P. Jannet, 1857, 1858.

fact, Buffon merely undertook to give a description of the King's physical cabinet, but he has used it as a starting point from which to deduce a general and hazardous physical system, a system new and impossible, although he had himself inveighed against general systems."

D'Argenson's mémoires show that he was implicated in all the intrigues and tittle-tattle of the court of Louis XV. He has been so often convicted of inaccuracy that we are not bound to accept his statement in regard to the authorship of the *Letters to an American* or of Réaumur's envy of Buffon's works and emoluments, at their face value. When we turn to the thirteenth of these letters we find that de Lignac presents a very different version of the affair: * "The fourth reproach addressed to me by M. de Buffon's party touches me most keenly. They say that I have lent myself to the exasperation of a savant, with whom I have the honour to be on very intimate terms. Although I readily divined in the course of taking extracts from the *Histoire Naturelle*, that certain satirical remarks were meant to apply to that savant, I did not venture to ask him for an explanation of the cause of his confrère's bad humour, and I was unable to obtain an explanation, except from others, indirectly and sometime after the publication of my first letters. But you know very well, Monsieur, that although I was ready staunchly to defend him, I was not bound by my regard for him to undertake the refutation of M. de Buffon's philosophy." An examination of the work shows that it is largely concerned with refuting the peculiar views of Buffon, Condillac and Needham and that the references to Réaumur are mainly in the twenty-second letter, in which Buffon's rejection of prevision in bees, ants, birds, etc., is considered. D'Argenson's statement that Réaumur was the author and that de Lignac edited the work, is preposterous. The style is entirely unlike Réaumur's, and it is inconceivable that he could have indulged in the kind of philosophical discussion to which the work is devoted. Abbé de Lignac

* Abbé F. A. le Large de Lignac, *Lettres à un Amériquain sur l'histoire naturelle, générale et particulière de Monsieur de Buffon*. 5 vols. Hambourg, 1751–1756

was, so far as I am able to learn, an estimable person,* a follower of Descartes and Malebranche, the author of several philosophical works and of a paper on aquatic spiders.†

The only allusion I have been able to find to the quarrel with Buffon in Réaumur's scientific writings, is in the postscript to his article on preventing evaporation from museum jars,‡ and this allusion is to Daubenton. Réaumur had read the article in the Academy, but before it could be published, Daubenton had obtained an extract of it through the perpetual secretary, de Fouchy, and had published it under his own name. Réaumur remarks: "I know not whether I owe thanks to M. Daubenton, to whom I can impute no intention of wishing to be disagreeable to me, but there is no doubt that the Academy has reason to be displeased with the procedure, for it can hardly fail to note the possible consequences of such an example being imitated." De Lignac, referring to this remark says very justly that "Réaumur modestly complained of this little literary theft," but Cuvier in his reference to the same passage says that he "complained violently." Though trivial, this judgment would seem to indicate that Cuvier sided with the Buffon-Daubenton faction rather than with Réaumur. But there are other considerations that point in the same direction. Cuvier's life of Réaumur, quoted above, is rather frigid compared with his lives of Buffon and his collaborator. Furthermore, Cuvier as a child was inspired to become a naturalist by reading Buffon.§ Born in 1769, he had never known Réaumur

* See his biography by Tabaraud, in the *Biographie Universelle*, vol. 24, 1809, p. 477.

† "Mémoire pour servir à commencer l'histoire des araignées aquatiques," 1748 (8°), 1799 (12°). De Lignac is repeatedly mentioned in Réaumur's letters to Séguier (Dec. 9, 1751, May 2 and 30, 1752, Aug. 21, 1753). In the letter of Dec. 9, 1751, he says: "The author of the *Lettres à un Amériquain* is a priest of the Oratory, whose name is no longer concealed. He is called de Lignac and though he has been the superior of the Oratorian order at Nantes prefers to live privately at Saumur, where he is at present. He comes every year to spend his vacations with me. He is excellent company. I shall not tell you that he is a solid reasoner, a great metaphysician, a lover of natural history, a geometrician, etc. Of all this you will be amply convinced by his work."

‡ Mem. Acad. Sci. Paris, 1746 (1751).

§ "A copy of Buffon, which he chanced to find in the library of one of his relatives, suddenly inspired him with a taste for natural history. He applied himself at once to copying the figures and colouring them to conform with the descriptions, an occupation which in the development of his tastes already revealed a sagacity of observation of a high order." P. Flourens, *Cuvier, Histoire de ses travaux*, 2d edit. Paris, Paulin, 1845, p. 65.

and being a museum man, his associations with Buffon and Daubenton were very intimate. He succeeded the latter in 1799 as professor of natural history at the Collège de France. Those who have lived long in a museum or university atmosphere will have no doubt that he must have heard plenty of unfavourable comments on the great entomologist who had aroused the animosity of the intendant and chief assistant of the Cabinet du Roi.*

Looking back from the vantage-ground of present-day science we cannot blame the irritation of Réaumur. It is the old story of the able and conscientious investigator who finds himself outstripped in popular esteem by the hyperkinetic *arriviste* with rhetorical pretensions. None of the earlier naturalists has suffered such a decline in the estimation of his successors as Buffon. He was not a naturalist, but a philosopher,† and a rather crude philosopher at that, who owed all that was of lasting value in his work to his collaborators Daubenton, Abbé Bexon, de Montbeillard and de Lacépède. As Maury says, he "cast no fecund light into the future (as did Lavoisier or de Jussieu), he formulated no law, opened up no new path, and his heritage was soon exhausted; but if his vision lacked penetration, it nevertheless embraced a wide horizon." It is now clear that even his views on the evolution of the earth were derived from Leibnitz and certain little-known French and British geolo-

* The following interesting passage on the work of Buffon and Daubenton and their collections occurs in Réaumur's letter of May 25, 1749, to Séguier: "It is true, Monsieur, that they are printing a description of the King's cabinet, and, moreover, according to the newspapers, of which I fail to find a copy to send you, they announce a general natural history. I have no part in this work and know nothing about it, though three of the promised volumes have been printed already. M. de Buffon, intendant of the King's garden and treasurer of the Academy and M. D'Aubenton, custodian of the King's cabinet, have undertaken this great project. I know not how they will carry it out, because I have seen none of this kind of work by either of them. I know that they have had many extracts made from the works of naturalists and travellers, but I know not what they themselves have observed. The cabinet in the King's garden is not rich in insects, in minerals or birds. The basis of the bird collection consists of 60 or 80 specimens which they have had prepared in Strasburg and which last year were mostly devoured by museum pests, because they did not know how to preserve them. But the collection is rich in plants, precious stones and shells."

† M. Caullery, "Histoire des Sciences Biologiques," in G. Hanotaux, *Histoire de la Nation Française*, 1924, p. 114.

gists, and that their vastness was largely verbal.* Réaumur was not, of course, the only clear-sighted critic of Buffon. Miall †, while contending that we owe much to Buffon as a popularizer of science, says that the majority of professed naturalists of the time in France, Germany and England, "held that no loftiness of thought and diction, no liveliness in description, no startling theories of creation could atone for Buffon's contempt of system, or for the blunders which disfigured his pages. Many contrasted the accuracy of Daubenton with the carelessness of Buffon, or said with D'Alembert that Buffon was "le grand phrasier, le roi de phrasiers." There can be no doubt that he made many personal enemies.‡

Réaumur's opinion of Buffon is expressed in his letter of May 3, 1750, to Ludot: "Since you are accustomed, Monsieur, to analyzing ideas and adopting only those that are correct, M. de Buffon's pompous manner will not persuade you to accept his queer notions. Had you read his first volume you would have been no more satisfied with it than with the second. The three together can only impede the progress of natural history and physics in general, should the propositions they contain be adopted. But I learn on all sides that one shriek of protest has been raised against the work, and this may indicate that the subsequent volumes are not to be feared. Moreover, there is little confidence in the facts reported by the author in so far as they are based on his own observations."

But there is another aspect to the disagreement between Réaumur and Buffon, which has a bearing on the paragraph in brackets appended by Miall to Cuvier's biography: "During the years 1742–57 Réaumur hardly published anything," etc. (p. 13). This paragraph is disconcerting when we consult

* Even Buffon's "organic molecules," the precursors of the "genes" of modern geneticists, were anticipated not only by Bonnet but also by Réaumur as early as 1712 in his work on the regeneration of crustacean appendages. He calls them "petits œufs," however, and postulates their existence, in cautious and conjectural language, as the causal factors in the regeneration of organs. *Réaumur should therefore be recognized as the first to ascribe reproductive processes in organisms to the presence of ultramicroscopic living particles.*

† *Early Naturalists*, loc. cit., p. 387.

‡ "M. de Buffon has a great number of enemies among the savants of this country," etc. Montesquieu, *Lettres familières*, Lettre à Monseigneur Cerati.

the bibliography and find that Réaumur published in the interval between 1742 and his death some sixteen books, articles and notes and among them the following works of considerable importance: First, in 1746, the article on preventing evaporation from museum jars, a work deemed sufficiently valuable to be translated and published in the Transactions of the Royal Society; second, in 1749, the work in two volumes of 478 pages, with 15 plates, on the artificial incubation of fowls' eggs; third, in 1752, the two papers on digestion in birds, which Miall deems sufficiently "memorable in the history of physiology" to review in the longest paragraph inserted in Cuvier's biography (!) and of which the biochemist J. Needham * has recently remarked: "Réaumur in 1752 was the first to study enzymes from the digestive juices outside the body and to show that the processes of life possessed a definite optimum temperature." And fourth, Réaumur published in 1753, in his best manner, his *History of the Worm-lion* (*Vermileo*), an important and extremely interesting paper, which I hope to consider more fully elsewhere in connection with my own studies on the European and North American worm-lions. That he was busy during his last years with various investigations in the processes of making anchors, pins, steel, etc., is indicated by the posthumously published works appended to the bibliography (see p. 274). Réaumur's letters, however, show very clearly that during the period from 1743 to the time of his death he had became intensely interested in ornithology. He was not only working and publishing on artificial incubation of fowls and on digestion in various birds but also amassing a great ornithological collection from various parts of the world. This led him to give much attention to taxidermy, on which he published the earliest treatise.† Far therefore

* *Mechanistic Biology and the Religious Consciousness in Science, Religion and Reality*, Macmillan, 1925, p. 233.

† Musset cites this work, the *Mémoires sur la préparation des objets d'histoire naturelle*, as published in 1745. No copy of it seems to be extant. It was probably reprinted posthumously in 1767 as a whole or in part in the quarto entitled *Mémoires sur les cabinets d'histoire naturelle*. This work is cited by V. Quérard, *La France Littéraire*, vol. 7, 1835, p. 481. The letters to Séguier contain a very interesting account of the methods employed by Réaumur and contemporary naturalists and explorers in preserving birds.

from terminating a strenous life "in comparative inertia," as Miall conjectures, we have every reason to believe that Réaumur was an active investigator with unimpaired faculties till the very time of his death.

The fact remains, nevertheless, that the four concluding volumes of Réaumur's greatest work, the *Mémoires pour servir a l'Histoire des Insectes* were never published, and the foregoing considerations leave this omission as a standing enigma. The first volume had been issued in 1734, the second in 1736, the third in 1737, the fourth in 1738, the fifth in 1740 and the sixth in 1742. If we allow for an average period of two years between volumes, the seventh should have appeared in 1744. The manuscript which I publish shows that Réaumur was working on this volume in 1743 and 1744, but though he lived thirteen years longer, the work remained uncompleted. To account for this fact we might make several conjectures, some of which may be briefly considered. I have given reasons (p. xi) for assuming that the seventh volume was to begin with the history of the ants, and the manuscript shows that there were several essential points in their behaviour, especially the founding of colonies, in regard to which Réaumur had reached no satisfactory conclusions as late as the summer of 1744. He was, perhaps, hoping for more light on this and many other peculiarities of the ants before finishing their history. The delay was probably long and, as often happens when a great work has been protracted through many years, a delay in its resumption may be fatal to its completion, and such delays seem to be most serious in the case of men advancing in years. It is possible, though not probable, that after the resumption of the work had been delayed for some years, the appearance in 1749 of Buffon's first volumes and the popular success which they achieved may have filled him with discouragement and a fixed determination never to complete the work. It might also be supposed that the work was discontinued through some intrigue for which Buffon was responsible. This is, perhaps, suggested by the following passage in de Lignac's *Letters:* * "M. de Buffon arouses my curiosity

* Lettre XXII, 1751, p. 202.

when he talks about the ants. I know that their History was long since completely finished, and what I have seen of these animals during my various excursions, seems to me to be so interesting that I cannot refrain from complaining about the theft that is being made on the public, in leaving this History in the cabinet and in interrupting that of the Insects, so entertaining, so instructive, so suited to disabusing us of our false notions concerning the great and the small and to elevating us to the Creator." This passage can be construed only as an allusion to the *Histoire des Fourmis*, published in this volume, and to the concluding volumes of the *Mémoires*, and as signifiying that the work may have been stopped through no fault of its author. Are we justified in supposing that Buffon's influence with Madame de Pompadour persuaded Louis XV to ask the Imprimerie Royale to discontinue or at least to suspend the printing of the *Mémoires?* That the King's mistress interfered in the affairs of the academicians, as she interfered in innumerable other concerns of the government is abundantly substantiated.* The various conjectures here discussed seem to be set at rest, however, by the following sentence which I find in Réaumur's letter of April 3, 1751, to Séguier: "Occupations, which are constantly intervening, prevent me from publishing the continuation of my mémoires on the insects; for example, I am actually obliged to look after the reprinting now under way in the Louvre of my '*Art de faire éclore les oiseaux domestiques.*'" This remark and many passages in other letters show that Réaumur had lost none of his interest in the insects and that at least as late as 1751 he still hoped to publish additional

* See e.g. d'Argenson, *Mémoires*, loc. cit., Vol. IV, p. 143: "The Marquise de Pompadour had given her word to Piron for the first vacant place in the Académie Française, but now the King refuses to grant it. The former bishop de Mirepoix has shown the King the *Ode to Priapus*, a work written by Piron in his youth, and this has brought about his exclusion. Buffon and D'Alembert have withdrawn from the vacancy, in order in their turn to avoid some infamous notice of the same kind, the former having contradicted Genesis. Only nonentities (*plats pieds*) remain to be elected. There is still Bougainville, but he is suspected of being a Jansenist, and Condillac, but he has talked too much about the soul. This continual exclusion is an indiscretion on the part of the sovereign. The late King employed it only once in his lifetime. The more the priests are hated, the harder they work to make themselves odious." There are similar remarks on Madame de Pompadour's activities in a letter of Troublet to Madame de Vertillac, published by Musset in Réaumur's correspondence.

volumes of the mémoires on the insects. His interests and qualifications were so varied and many of them in fields so inaccessible to any influence emanating from Buffon and his supporters, that he must have found plenty of opportunities for productive investigation. Men of a similar polypractic type were conspicuously numerous in the eighteenth century and nowhere more numerous than in France. Even in the United States we had men like Benjamin Franklin and Thomas Jefferson. Besides Voltaire, D'Alembert and Diderot, there were in Réaumur's more immediate environment lesser luminaries who displayed unusual versatility, like Duhamel du Monceau (1700–1781) who did valuable work in physics, chemistry, zoölogy and botany, and Dufay (1697–1739), who was the only member of the Academy of Sciences able to publish mémoires in all six of its departments: chemistry, anatomy, botany, geometry, astronomy and mechanics.

The biographies of such versatile beings are usually more or less unsatisfactory or incomplete, because the biographer is rarely able to evaluate more than one of their numerous specialties. This is notably true of Réaumur, who is, of course, well-known to physicists and meteorologists as the inventor of the thermometer and to metallurgists as the inventor of a process of making steel, but is rarely known to them as having been at the same time the most remarkable of entomologists, while entomologists are not, as a rule, acquainted with his important contributions to other departments of zoölogy or to metallurgy, etc. And when his biographers enumerate the whole series of his achievements, one is left without any adequate comprehension of the abiding central interest which must have prompted him to such diverse activities, and he becomes a kind of multiple personality, devoid of psychological unity. Now Réaumur was a great pioneer physical and biological engineer in the best and broadest modern sense of that term.* This is, indeed,

* Réaumur, indeed, appears as one of the leading engineers in the industrial revival in France during the first half of the eighteenth century. This revival is described as follows by Henri Sée in *La France Economique et Sociale au* XVIII^e *Siècle*, Paris, A. Colin, 1925, p. 129: "In the meantime, we observe a pronounced industrial progress between 1715 and 1750, especially after 1730. Thus the manufacture of silk, of gold and silver fabrics spreads in

obvious when we consider all his work in metallurgy, glass and porcelain manufacture, etc., but it is equally obvious in his biological work when this is carefully scrutinized. Although he had the highest regard for what we call "pure science," no one was ever more constantly on the look-out for its applications to human welfare. This is clearly seen in his entomological work. In several places in the *Mémoires* * he states that what interests him most in the insects is their industries, or engineering behaviour ("génie") and he clearly realized that in studying their histories he was not only revealing the wonders of their lives but demonstrating that it is only through such studies that we can control and utilize these diminutive engineers to our own advantage. His insistence on this matter is so obvious that he may truly be said to be the creator of economic entomology.†

The least satisfactory and most archaic portion of Réaumur's work is his classification of the insects, but we must remember that the *Mémoires* were prelinnæan and that only such classifications as those of Ray, Aldrovandi, Vallisnieri and Swammerdam were in general use during the first half of the eighteenth century. Although Ray seems to have recognized the species as the basis of classification, the binomial nomenclature introduced by Linnæus had not yet been widely adopted. Hence our doubts in regard to the specific identity of some of the insects studied by Réaumur.

Paris and in the South; in Languedoc the textile industry seems to be very flourishing; in the East and in Normandy the cotton industry is greatly developed; being a new manufacture in France as in England, it is less affected than others by governmental regulations. Then there are the new tinplate factories, and in the Dauphiné new steel mills. The coal mines, previously but little and imperfectly utilized, are exploited with improved methods in the North and the Saint-Etienne basin; the mines of Anzin and Carmaux become active, and the mandate of 1744 puts new life into the coal industry. More attention is paid to its development owing to the keener preoccupation with deforestation, for which the foundries and factories are held to be responsible."

* I have quoted three of these passages in Note 10 (p. 224).

† This is also Rabaud's opinion: "We must also maintain that Réaumur was the first to demonstrate the practical usefulness of the study of insects. Certain caterpillars, for example, which devour the leaves of cabbages, flee the light and bury themselves in the ground during the day. The depradations are noticed, but their authors will remain unknown as long as this peculiarity of their mode of life is unknown." *J. H. Fabre et la Science*, Paris, E. Chiron, 1924, p. 14.

Moreover, any adequate classification of insects might be expected to be of very slow growth, owing to the enormous number of species, their complicated development and the fact that they were supposed to include many other invertebrates now regarded as distinct classes or even phyla. It is evident also that entomologists would be slow in adopting new principles of classification that had been found useful in other groups of animals. The history of zoölogical classification is, of course, a great subject, which we cannot at present consider.* It will suffice to call attention to a few peculiarities of the earlier systems. Those of Aldrovandi and Vallisnieri† are based on disparate principles, i.e., those employed in classifying insects were obvious, superficial physiological and ethological as well as morphological characters. The ethological characters served mainly in defining the higher or larger, the morphological the lower or smaller taxonomic categories. Swammerdam complicated matters by introducing developmental characters drawn from the various types of metamorphosis. As we approach the beginning of the nineteenth century the tendency of classification is seen to become increasingly morphological. This is apparent both in the entomological systems of Linnæus, Fabricius and Latreille and in the more general zoölogical systems of Lamarck and Cuvier. By the middle of that century the old view that only the species are objectively real, whereas all the higher categories are subjective, was replaced in the opinion of some taxonomists, e.g., Louis Agassiz, by the notion that even the higher categories have objective validity. Finally, with the triumph of evolution, classification is revolutionized, and as a concise expression of

* An admirable outline of it is given by E. Ray Lankester in his article "Zoölogy" in the *Encyclopædia Britannica*.

† Aldrovandi (*De Insectis*, 1602) had subdivided insects into two main classes, terrestrial and aquatic, and each of these in turn into several groups according to the locomotor organs, etc. Vallisnieri (*Esperienze ed Osservazioni*, etc., 1713, 1726) has an elaborate chapter on insect classification. He separates them into four "universal genera," or classes: those that inhabit plants, the aquatic forms (including the Crustacea), those that dwell in the rocks and earth and those that live in or on animals. The last genus includes also the parasites of other insects. He distinguishes some 41 groups in the first genus, according to the part of the plant infested. In defining the smaller categories and the species he resorts to external and internal structural differences.

the putative genetic relationships of the forms classified, acquires much greater significance. At the same time, all the categories, except the lowest, that of the individual organism, are henceforth conceived as having only subjective validity.

Now an observer like Réaumur, intensely interested in the physical and engineering sciences, when confronted with the task of bringing order into the intricate welter of phenomena presented by the insect world, might be expected to turn away from a structural and to incline towards a functional or dynamic classification. He would naturally seize on peculiarities in the behaviour of the organism as furnishing the most rational and most useful general differentiæ of the various groups. That he actually had this preference is proved by the arrangement of the insects in the *Mémoires* and by his remarks in the introductory chapter.* He says in one place: "The history of the insects is a great, I might say a vast domain, which may be traversed by many paths. The portion most interesting to me is that to which the majority of people are most susceptible, namely, the portion comprising everything relating to the engineering, the habits, in a word, to the industries of these small animals." It seems, therefore, that Réaumur brought to his study of insects the same practical interests which had guided him in his studies of human industrial processes. The word "industry," as employed by him and later by other French entomologists, such as Latreille and Dufour, is clearly the equivalent of our modern word "behaviour." But how much more concrete and unsophisticated is this earlier term, which so aptly expressed the diligence and perseverence of insects, their tunneling in wood and other solid substances, their wonderful architectural exploits in wax, paper and innumerable other materials, their spinning and weaving, their cultivation of mushrooms, herding of plant-lice and storing of seeds, pollen, honey and paralyzed prey! To the eighteenth century observer the insect was above all things a worker, an artisan, and we must adopt this point of view if we would appreciate the *Mémoires*.

* *Mémoires*, I, 1734, p. 1–58.

This consideration somewhat lessens our surprise on finding the following passage at the beginning of the introduction: "I confess that I am not in the least inclined towards a precise enumeration of every kind of insect, even if it could be undertaken. It seems to me sufficient to consider those kinds which prove to us that they deserve to be distinguished, either on account of their peculiar industries or because of their unusual structure or because of other striking singularities. It seems to me that the many hundreds and hundreds of species of gnats and very small moths which exhibit nothing more remarkable than a few slight differences in the form of the wings or the legs, or varieties of coloration or of different patterns of the same colours, may be left confounded with one another." More startling is his conception of the insects as a natural class, since, like other naturalists of his day, he not only included in it the worms, polyps, mollusks, arachnids, myriopods and crustaceans, but also the reptiles. He says: "The crocodile is certainly a fierce insect, but I am not in the least disturbed about calling it one."

Why are we, who are so much interested in the precise wing-venation of every insect and the configuration and distribution of its hairs, scales and other structural minutiæ, so shocked at this attitude, which Réaumur shares with his contemporaries Trembley, Lyonet, Rösel von Rosenhof, etc.? Obviously because we are all so thoroughly imbued with the doctrine of evolution and all that it implies that we are unable to observe organisms from the standpoint of the early eighteenth century naturalists. Our eagerness to detect possible genetic affinities is so inordinate and so absorbing that every minute vestigial and apparently functionless structural detail assumes extraordinary significance in our eyes, and the conviction that our classifications must mirror at least approximate phylogenies makes even the obscurest organism seem very important. We can place no bounds on our inquisitiveness, we have lost both the courage to ignore details and the ability to see the organic world in anything but the most intricate morphological perspective. The

interests of the early eighteenth century naturalist, however, were more eclectic and therefore both more practical and more artistic. He was interested primarily in the activities of animals and in unusual structures only in so far as they implied unusual functions. The crocodile was to him an insect, because it behaved precisely like a huge, predacious, amphibious insect, and the honey-bee, caddis-fly and ant-lion were more interesting than forms like Amphioxus, Balanoglossus and Peripatus, because their activities made a much more direct and intelligible appeal to the human observer. Hence Réaumur classified the insects in his *Mémoires* primarily according to their "industries."

But what was unavoidable and pardonable in Réaumur becomes avoidable and unpardonable in Buffon, who, though living at a time when the systems of Linnæus (1707–1778) and A. L. de Jussieu (1748–1836) had been perfected, nevertheless alludes with ill-concealed contempt to these and other "nomenclators." According to Miall:* "At the outset of his undertaking Buffon made a particularly grave mistake. He attacked, needlessly and ignorantly, two naturalists whom he ought to have conciliated, for each in a way of his own, was labouring diligently and successfully to promote Buffon's cause. They were not men to be trampled upon with impunity; the one who had most ground of complaint was Linnæus; the other, who is dismissed with a few contemptuous phrases, was Réaumur. Nowhere does Buffon expose his own weakness more irremediably than in carefully studied passages which were meant to wound. . . . To Buffon the arrangement of animals and plants was a problem of the same kind as the arrangement of the books in a library. All groups are as arbitrary as the alphabet, and he prefers that arrangement, whatever it is, which is most serviceable to a popular writer. . . . The ancients, especially Aristotle and Pliny, were, he thinks, far better qualified to write upon natural history than any of the moderns. They did not trouble themselves about *useless insects whose manœuvres gratify some modern observers* (this is meant for Réau-

* *Early Naturalists, etc.*, p. 370 ff.

mur), nor count the stamens of plants which possess no medicinal virtues. It would be better to do as Pliny did, and simply name in alphabetical order at the end of the series *all* the plants which have no useful properties. . . . Then Buffon sketches such a natural history as he would himself approve. Knowledge is divisible into Civil History and Natural History. Natural History should mainly consist of descriptions of natural objects, not minute, not formal; they should above all be readable. The grouping should be such as would suggest itself to the first human observer, and the succession should be determined by the closeness of the relation to man. It is a mistake to let the description of the zebra, which is foreign and unfamiliar, follow that of so well-known and useful an animal as the horse; the dog, which we are accustomed to see running at the horse's heels, might much more fitly come in this place. The natural and ordinary way of looking at things is the best."

Although Buffon was ultimately compelled to change his opinions, he merely returned to such an out-of-date classification as Ray's. His views on taxonomy when compared with those of Réaumur can only be designated as absurd. The latter's ethological classification, however, is still thought-provoking and may, perhaps, even be prophetic of future developments in taxonomy. The great systematists since Linnæus have tacitly assumed that only morphological criteria should have a place in classification and that physiological and ethological considerations should be studiously avoided. The reasons for this contention are obvious, but it may also be maintained that an ideal genetic classification should deal with organisms as wholes and therefore include their functional peculiarities. As a matter of fact, our modern systems do give a prominent place to embryonic characters and are constantly utilizing convergence, or parallel development, specialization and "degeneration" as the result of adaptation, etc., and these principles are clearly functional. Furthermore, in entomology as in other domains of zoölogy we are now confronted with the problem of physiological and ethological species, that is, with forms which

show little or no appreciable difference in structure but which differ greatly in behaviour. Giard in his paper on poecilogony * called attention to a long list of forms which are almost or quite indistinguishable as adults but differ in their development, and others have from time to time detected differences of habit and habitat, seasonal distribution, and immunity to disease, etc., in forms otherwise indistinguishable. † No doubt many more such cases will be brought to light and will have to be provided for in our classifications. Hence the taxonomy of the future may be expected to place increasing stress on physiological and ethological characters. We may say that our present systems provide only for a completed evolution, not for one that is actually taking place, that is, for one in which the functional has not yet had sufficient time to acquire macroscopically or even microscopically detectable, though it very probably has chemically detectable, structure. The future task of taxonomy, it will be admitted, is a formidable one, but must be undertaken if classification is to be a system embodying in condensed form all the ascertainable data, functional as well as structural, relating to the genetic affinities of organisms, past and present. The exclusion of physiological and ethological characters from our existing systems is due partly to the great difficulties of including them without introducing confusion, and partly to our ignorance of the behaviour of the great majority of animal species.

It was, of course, inevitable that Réaumur, while studying the industrial activities of insects, should come face to face with the problem of instinct. Flourens‡ even regards him as the first to have undertaken a positive observational study of the "inner faculties" of animals, and it does appear that his work precedes that of Reimarus§ who is usually

* A. Giard, "La Poecilogonie," *Bull. Scient. France.* Belge 39, 1905, p. 153–187.

† *Cf.* F. C. Craighead, "Hopkins' Host-Selection Principle as related to Certain Cerambycid Beetles," *Journ. Agric. Research 22*, 1921, p. 189–220; and B. B. Fulton, "Physiological Variation in the Snowy Tree-Cricket, Oecanthus niveus De Geer," *Ann. Ent. Soc. Am. 18*, 1925, p. 366–383.

‡ *De l'Instinct et de l'Intelligence des Animaux*, 2d ed., Paris, Paulin, 1845, p. 21.

§ *Allgemeine Betrachtungen über die Triebe der Thiere, hauptsächlich über ihre Kunsttriebe*, Hamburg, 1762.

cited as the earliest critical student of instinct.* But Réaumur rarely expresses himself in very general terms and seldom uses the word "instinct," but *adresse*, that is, dexterity or skill, or *industrie*, which, as I have stated, is really a synonym of "behaviour." On one of the few occasions, when he indulges in general discussion, he says:† "But shall we refuse the insects all intelligence? Shall we reduce them to the simple status of machines? This is the great question of the animal soul, agitated so often since M. Descartes, and in regard to which everything has been said since it was first propounded. All we can conclude from the discussions that have thus arisen is that the two opposite views maintain only what is very probable, but that it is impossible to prove which of the two is true. If somebody should wish to hold that God could make machines capable of growing, multiplying and doing everything that insects and other animals do, who would dare deny that the Omnipotent could accomplish so much? But if somebody should hold that God could endow insects with an intelligence equal or even superior to our own, without enabling us to know that He had thus endowed them; and if this somebody should hold that an oyster, vile as it is in our sight, attached to a rock and condemned to a mode of life which seems to us very gloomy, may nevertheless enjoy a very delightful existence, being constantly engaged in lofty speculations, it would be impossible to deny that the Supreme Power could go so far or even farther; He can create and place intelligences wherever He desires.

"We behold in animals, and in the insects as fully as in any others, processes which incline us to assume a certain degree of intelligence. We are led to take this view by reasoning from analogy. But the insects are reproached with having processes that are too uniform; they do not exhibit sufficiently varied activities. This history, however, will give us occasion more than once to remark that there are

* Condillac, with his *Traité des Animaux*, 1755, also precedes Reimarus. For a recent analysis of the works of these authors see Wilm, *The Theories of Instinct*, New Haven, Yale Univ. Press, 1925.

† *Mémoires I*, p. 21.

insects that know how to vary their procedure when this is required by the circumstances. It is true, nevertheless, that every species of insect has, so to speak, only its own particular dexterity by means of which it appeals to our admiration. But even if the insects performed actions more surprising and more varied, or series of actions, like our own, they would yet gain nothing in the estimation of those who are determined to refuse them souls. The metaphysics of a savant [Leibnitz], illustrious in so many different fields, has convinced him that we ourselves, viewed from the outside, act as pure machines, that every human body is a machine constructed to perform a series of movements and actions, and that this series is what the soul, destined to inhabit the body, wills it to perform as long as it is thus inhabited."*

Flourens† believed that there are two kinds of instincts, "moral" and "mechanical instincts," the former being what we now call the instinct feelings (emotions, cravings, appetites), the latter the instinct actions of a mechanical (chain-reflex) pattern. These he regarded as the instincts proper, and he gave Réaumur credit for having first critically studied them, whereas he believed Buffon to be the first to recognize the moral instincts, which he also regarded as constituting the disposition, character, or *naturel* of the animal. While, in my opinion, Buffon is here undeservedly given credit for first recognizing psychical phenomena that were well known even to Aristotle, the scholastics and Descartes, I would agree with Flourens when he says that "no one ever so little understood instinct properly so-called as Buffon." This is evident from several passages in the latter's *Discours sur les Animaux* at the beginning of the fourth volume of the *Histoire Naturelle* (1753), passages undoubtedly written with the intention of undermining Réaumur's repu-

* See also the passage in Réaumur's letter of Feb. 23, 1756, to Haller on Condillac's conception of the animal soul and the remark: "The Abbé Condillac's explanation of instinct would please me if, unfortunately, I did not observe that very instinct acting on innumerable occasions before it could be acquired by repeated acts. This author's work on the animals has been recently attacked by Abbé, formerly Father de Lignac in such a manner as to make it difficult to defend," etc.

† *Journ. des Savants*, 1860, *loc. cit.*, and *De l'Instinct et de l'Intelligence*, etc., *loc. cit.*

tation by distorting the meaning of his statements and vilifying not only his fine enthusiasm but even the very organisms which he investigated. Here is an example (p. 91): "Independently of the enthusiasm one may have for a subject, one always admires the more, the more one observes and the less one reasons. Is there, in fact, anything more gratuitous than this admiration for bees, than these moral views with which they are supposed to be endowed, than this love of the common weal which they are supposed to have, than this extraordinary instinct which equals the most sublime geometry, an instinct recently attributed to them and in obedience to which bees solve without hesitation the problem of building their comb in *the most stable manner possible, in the smallest possible space, and with the greatest possible economy*? What shall we think of the excess to which the details of these eulogies have been carried? For, in the end, a bee should not occupy more space in the head of a naturalist than it does in Nature; and this marvellous republic of flies will never be more in the eyes of reason than a swarm of little beasts that have no other relation to us than to supply us with wax and honey." He then proceeds (p. 99) to give us one of those delightfully simplicist "explanations," which we encounter even at the present time: "These cells of bees, these hexagons, so much extolled, so greatly admired, furnish me with a further proof against enthusiasm and admiration. This shape, perfectly geometrical and perfectly regular, is here merely a mechanical effect and a rather imperfect one at that, like those which often occur in Nature and are observed even in her crudest productions. . . . If you fill a vessel with peas or better with some other cylindrical seeds, close it tightly, after having poured in enough water to fill the interstices remaining between the seeds, and then boil the water, all the cylinders will become prisms with six surfaces. Obviously the reason for this is purely mechanical: every seed, whose form is cylindrical, on swelling tends to occupy as much room as possible in a given space; hence they all become hexagons by *reciprocal pressure*." Buffon, who was so ignorant of what

had been done in entomology and general biology that he was still advocating spontaneous generation in the nematodes of flour paste, in earthworms and fungi, after it had been disposed of by Redi nearly a century before, here shows himself to be equally ignorant of the work of Swammerdam and Réaumur on the bees. Commenting on the foregoing passage, Flourens points out* "that each cell [of the comb] is a small, perpendicular edifice carved and erected bit by bit, that there are cells of several different kinds, for the worker larvæ, for the eggs that develop into males, for the female that is to develop into a queen, etc. Moreover, he did not consider that such a puerile conception as *reciprocal compression* is no explanation, either of the cocoon of the silk-worm, or of the web of the spider, etc., etc."

If we make due allowance for the period in which Réaumur lived and wrote, it is clear that his view of animal behaviour was not unlike that which we hold at present. He knew that most insect activities are highly mechanized reactions but that they are capable of a limited adaptive modification, or plasticity in response to changing conditions. He was, moreover, quite aware, as one of the foregoing quotations shows, that the psychological interpretation of animal behaviour is extremely difficult and that it must differ with the *Weltanschauung* of the interpreter, that is, according as he is a nativist or an empiricist, an idealist or a materialist, etc. Réaumur chose what was in his time, at any rate, the wiser course of most carefully testing by observation and experiment the "industries" of animals, and of eschewing specious generalizations. We therefore look back to him as the founder of ethology,† or external physiology, a department of biology which is only now beginning to come into its heritage.

Réaumur's influence on his contemporaries and successors has been profound, especially in France, Sweden and Switzerland. In France the current of interest in the habits of insects, descending from Réaumur to the present day, is

* *Journ. des Savants*, 1860, *loc. cit.*, p. 143.

† See Caullery, *Histoire des Sciences Biologiques*, *loc. cit.*, p. 97.

clear and strong. His immediate successors were Latreille (1762–1833), Audouin (1797–1841), Lepeletier de Saint-Fargeau (1770–1845) and Léon Dufour (1782–1865), and it was the perusal of Dufour's essay on *Cerceris bupresticida* that determined Fabre's entomological career. In his *Souvenirs Entomologiques* he has left us an account of the event, which reminds us of some of William James' *Varieties of Religious Experience*. "There are for each one of us," he says, "according to his turn of mind, certain books that open up horizons hitherto undreamed of and mark an epoch in our mental life. They fling wide the gates of a new world, wherein our intellectual powers are henceforth to be employed; they are the spark which lights the fuel on a hearth doomed without its aid, to remain indefinitely black and cold. . . . One winter evening, when the rest of the household were asleep, as I sat reading beside the stove whose ashes were still warm, my book made me forget for a while the cares of the morrow; those heavy cares of a poor professor of physics, who, after piling up diplomas and for a quarter of a century performing services of uncontested merit, was receiving for himself and family a stipend of sixteen hundred francs, or less than the wages of a groom in a decent establishment. . . . It was a monograph by the then father of entomology, the venerable scientist, Léon Dufour, on the habits of a wasp that hunts Buprestis-beetles. Certainly I had not waited till then to interest myself in insects; from my earliest childhood, I had delighted in Beetles, Bees and Butterflies; as far back as I can remember, I see myself in ecstasy before the splendour of a Ground-beetle's wing-cases or the wings of *Papilio machaon*, the swallow-tail. The fire was laid; the spark to kindle it was absent. Léon Dufour's essay provided that spark. New lights burst forth; I received a sort of mental revelation."

It was Fabre who in turn profoundly influenced Paul Marchal, best known to zoölogists as the discoverer of polyembryony. Unlike Fabre, he eagerly accepted the doctrine of evolution. His essay on *Cerceris ornata*, published in 1887, seems to be the first work on insect behaviour from

the evolutionary point of view. At the present time Réaumur has a great number of followers in France. Besides the late Professor Giard and Marchal, who is still active, there are many like Pictet, J. Pérez, Du Buysson, Charles Janet, Ferton, Bouvier, Rabaud, Bordage, Picard and Roubaud, who have made notable contributions. Very much that is fundamental in our knowledge of the habits of many insects, and especially of the wasps, both solitary and social, is the work of these investigators and of their predecessors, Fabre, Dufour and Réaumur.

In Sweden Réaumur's influence was strongly felt by Carl De Geer (1720–1778), who became one of the greatest entomologists of the eighteenth century. His admiration for the French entomologist is shown in the fact that he not only took the *Mémoires pour servir à l'Histoire des Insectes* as a model in writing his principal work but gave it the very same title. Sweden and the other Scandinavian countries have since produced many specialists in insect ethology and may therefore be said to have continued the Réaumurian tradition. One of the most eminent of these, Gottfried Adlerz, has for many years past published fine investigations on the habits of ants and solitary wasps.

In French Switzerland, which has produced such an unusual series of naturalists, often belonging to more than one generation of the same family, as in the case of the Hubers, de Candolles, de Saussures and Agassiz, Réaumur's influence has been even more profound and more continuous. In Geneva, Charles Bonnet (1720–1793), at the age of eighteen, became an ardent disciple of the French entomologist, and it was Bonnet who encouraged the blind François Huber (1750–1831) in his famous work on the honey-bee. François Huber inspired his son Pierre (1777–1840), whose work on the habits of the Swiss ants is even more brilliant, though, owing to his possession of normal eyesight, he never aroused the same sentimental interest as his father. Pierre Huber's influence on Forel was extraordinary and was, as he informs us, transmitted to him in a peculiar manner.* After describing his interest in ants at

* *Le Monde Social de Fourmis*, Geneva, Kundig, 1921, p. 111.

the age of eight, he says: "My parents left Lonay in 1857 and I was sent to school at Morges, whence I often visited my paternal grandparents at their country-house, 'La Gracieuse.' Believing that I was cruel to insects, my grandmother asked my parents to forbid my collecting living insects. I then made a collection of insects found dead, and I continued observing the ants between La Gracieuse and Morges. But in 1859, when I was eleven, my great-uncle, Alexis Forel, who was a naturalist, interceded in my behalf, and one fine day my grandmother brought me the book of Pierre Huber, *Recherches sur les mœurs des fourmis indigènes,* published at Geneva in 1810. The copy had been dedicated to her by the author. She said to me: "I am giving you this book by my old partner in the dance, Huber. He was not cruel like yourself because he scolded me when I killed the ants that ate my preserves. I have never been able to read it through; it is not in my line." I not only read the book, I devoured it and I read and reread it. It was a revelation to me; it became my Bible. From it I learned to understand the slavery of my two species of ants at Lonay, my blood-red slave-makers and my amazons and my friends, the grayish-black ants of the terrace; I understood the eggs, larvæ, nymphs, cocoons and the winged sexes of ants as well as their social habits and their wars. I even noticed that one of my observations (on lestobiosis), made before my eleventh year, had escaped Huber. Then I vowed to myself that I would become like him, all my life, an historian of the ants; and I have kept my word." At the age of twenty-six Forel published the results of his early studies in his monumental volume on the Swiss ants.* Inasmuch as Santschi, Escherich, Kutter and I have been greatly influenced by Forel's personality and writings we may, perhaps, regard ourselves as spiritual great-great-great-grandsons of Réaumur. Thus notwithstanding the utter discontinuity of the chromosomes, except in the Huber family, the links of personal interest and influence remain unbroken from Réaumur to the present hour. Of course, the intercalation of Forel's

* *Fourmis de la Suisse,* 1874.

grandmother somewhat disturbs the flow of entomological preoccupation, but she supplies just that touch of romance so essential to every properly constructed genealogy. And now that advancing years yield only a more vivid realisation of the vast number of unsolved problems which we are bequeathing to our youthful successors, we can repeat the words of Seneca (*Epist. ad Lucilium, 64*): *Sed agamus bonum patremfamilias; faciamus ampliora quæ accepimus: major ista hereditas a me ad posteros transeat. Multum adhuc restat operis, multumque restabit; nec ulli nato post mille sæcula præcludetur occasio adhuc adjiciendi.**

* But let us play the part of a good father of a family; let us increase the patrimony which we received, in order that it may descend to our posterity more abundantly. Much remains to be done and much will still remain; nor shall any man born after the revolution of a thousand ages be denied the opportunity to contribute something.

HISTOIRE DES FOURMIS

HISTOIRE DES FOURMIS*

Quoique nous n'aions pas toujours a nous louer des fourmis on est assez generalement bien disposé pour elles; on n'a point pour elles de ces avertions qu'il est assez ordinaire d'avoir pour tant d'autres insectes. une des vertus des plus utiles a la société est l'amour du travail; nous aimons les hommes laborieux, et nous sommes portés a aimer de petits animaux qui le sont a un point ou il seroit a desirer que touts les hommes le fussent. il n'est personne qui n'ait eu occasion de voir des fourmilleres et qui ne se soit arresté a considerer l'activité, l'ardeur, et le courrage avec lesquelles le petit peuple qui les habite se livre a differents travaux; qui n'ait admire les efforts qu'y font des fourmis pour trainer des fardeaux qui semblent tres superieurs a leur forces. souvent apres en avoir observe une qui epuisoit inutilement les siennes pour remuer un brin de bois qui etoit pour elle une grosse poutre enorme, on en voit deux ou trois autres venir a son secours; dans une infinite d'occasions elles cherchent a s'entraider; a se soulager les unes les autres; la charge qu'une fourmi a transportee avec trop de fatigue jusqu'a un certain terme, lui est souvent otee par un autre fourmi qui la conduit plus pres de la fourmillere, ou a la fourmillere meme. il y a longtemps aussi que le sage a renvoye le paresseux a prendre des lecons d'elles. celles qu'elles donnent depuis si longtemps n'ont pas toujours ete infructueuses. Aldrovande[1] a voulu que nous crussions que nous etions redevables aux lecons des fourmis de tant de gros et scavants volumes qu'il a suffi a faire paroitre au jour; il nous assure que ce fut apres avoir admiré l'ardeur avec laquelle ces petits insects se livroient sans relache a des travaux penibles, qu'il eut honte de continuer la vie oisifve a laquelle il setoit laissée aller et

* The marginal notes of Reaumur's manuscript are here printed as foot-notes, in both the French text and the translation. The small numerals in both refer to the "Annotations."

pretend que l'exemple des fourmis a produit sur plusieurs grands hommes un effet semblable. et il ne manque pas de citer St jérome[2] qui raconte qu'il fut determine a une vie plus actifve apres avoir contemple avec admiration celle des fourmis, des travaux desquels il a fait une peinture elegante et vifve.

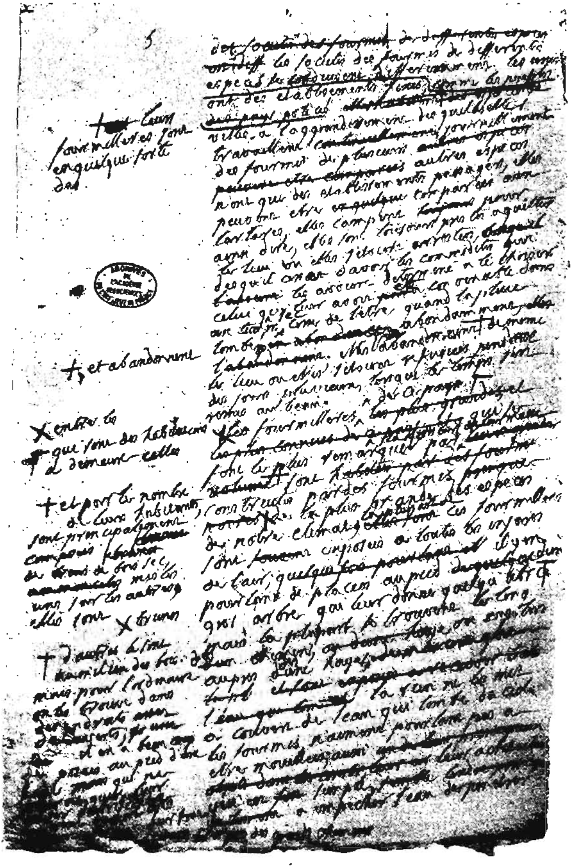
mais on ne s'en est pas tenu a admirer ce qu'elles nous permettent de voir. on a cherché a interprêter a leur avantage toutes leurs actions, celles mêmes dont les motifs sont le moins penetrables. nous avons deja dit ailleurs qu'on a prodigué a leur prevoyance des eloges qui ne lui sont pas dus. on a fait regner parmi elles une police sur laquelle la notre auroit pu prendre modelle, on les fait aussi civilisées que nous. on ne s'est pas contente d'assurer qu'elles ont des heures reglées pour le travail, et d'autres pour le repos comme elles en ont reellement; on a pretendu que comme nous elles avoient fixé leurs jours ouvrables et leurs jours de feste; les uns leur ont fait chaumer le premier jour de chaque mois; Olien[3] veut que ce jour là elles ne mettent pas le pied hors de chez elles et qu'elles s'y tiennent parfaitement tranquilles. d'autres pretendent que c'est le dernier jour de chaque mois lunaire qu'elles prennent pour leur jour de repos. d'autres plus profondement scavants dans leur kalendrier on voulu qu'elles eussent choisi pour jour de feste le 9e de chaque mois. elles ont bien plus que des jours de feste si nous en croions pline[4]; elles en ont ou elles tiennent des especes de foires. commes dans les jours de travail elles se dispersent a la campagne, qu'elles vont au loin, que chacune y fait sa besogne sans s'embarasser de ce que font les autres, elles viveroient ensemble sans se connoitre assez, si comme pline le pretend elles n'eussent etabli des especes de jours de foires dans les quels les connoissances se font ou se renouvellent. c'est dans ces jours ou elles n'ont rien autre chose a faire, qu'elles s'entre cherchent, quelles font mille et mille courses pour se trouver. on ne scauroit exprimer selon le meme autheur avec combien de civilite se saluent alors celles qui se rencontrent, le nombre de questions qu'elles se font, la politesse qui regne dans leurs entretiens.

ce n'est pas par pline seul c'est par touts les anciens naturalistes que les fourmis ont ete louees de ce qu'elles rendent a leurs morts

des devoirs semblables a ceux que nous rendons aux notres. ils ont assure que chaque fourmillere avoit son cimetiere.[5] *on a cru de plus que la fourmi morte n'y etoit transportee qu'apres avoir ete mise dans un cercueil; que les vivantes cependant n'etoient pas embarassees a lui en faire un, les coques vuides ou les folicules de quelques graines en seroient de presque tout faits, parmi lesquels elles scavoient choisir la plus convenable. Aelian nous rapporte ce qui determina cleanthis a accorder de la raison aux bestes quoiqu'il leur en avoit toujours refuse avec obstination. il fut temoin occulaire de ce qui arriva dans le transport du corps d'une fourmi, qui apparamment n'en etoit pas une du commun; celles qui le faisoient passerent trop pres de l'entrée d'un autre fourmilliere que la leur, ce qui apparemment parmi les fourmis est contre les règles aussi le corps mort fut-il arreste par celles de la nouvelle fourmillere. apres plusieurs discours que le spectateur n'entendit pas mais dont il scut bien deviner le sens le corps mort fut relaché mais ce ne fut qu'apres que les fourmis qui faisoient l'enterrement l'eurent rachete au moyen du present d'un ver de terre qu'elles firent aux fourmis par qui elles avoient éte arrestees. si je rapporte de pareils faits ce n'est assurement, ni pour les faire croire, ni pour les combatre mais parce qu'ils nous montrent les progrès de l'esprit humain. ce que des scavents ont debite autrefois serieusement a d'autres scavants a peine aujourdui des nourrices credules le conteroient elles a leurs enfants. mais si on est curieux de s'instruire de ce qui a ete dit a la gloire de ces petits insectes on n'a qu'a lire le 16 chapitre Du theatre des petits animaux publie par moufet.*[6] *ce chapitre n'est qu'un panegirique des fourmis, l'enumeration qu'on y fait des arts qu'elles scavent est longue, elles en ignorent peu de ceux qui nous mettent en etat de parvenir a construire des batiments, exceptes ceux d'employer le fer. toutes scavent les memes arts mais toutes ne sachant pas chaque art dans un egal degre de perfection chaque fourmi est destinée a exercer celui qu'elle scait le mieux. celle qui scait le mieux faire des voutes preside a leur construction, celle qui scait bien couper le bois s'y occupe, celle qui n'a que le talent de bien fouiller la terre ne travaille qu'a cela. leur bonte d'ame les porte a donner de charitables secours*

a leurs malades et habiles en medecine elles scavent leur en donner d'efficace, elles ont des magasins remplis de graines de presque toutes les especes la elles vont choisir la graine qui peut etre la plus salutaire a la malade qu'elles ont a traiter, elles la lui offrent mais ce n'est qu'apres avoir rendu cette graine, par des preparations, un remede encore meilleur qu'elle ne l'est naturellement. dans les arts elles sont pourtant bien moins estimables par leur science que par leur vertus morales il n'en est aucune qui ne doive leur etre accordee au jugement de quelqu'un qui est echante de leur modestie et surtout de celle avec laquelle elles marchent; que leur croir de la pudeur, qui veut que ce ne soit que dans l'obscurite qu'elles cedent au penchant qui les porte de multiplier leur espece et que ce ne soit jamais dans les jours destines au travail; elles ne croient dignes de la vie que celles qui connoissent le prix de l'emploi du temps; aussi la paresse est punie de mort parmi elles leur haine pour les cigales et pour les loirs est implacable parce que les unes passent l'ete à chanter, et les autres passent l'hiver a dormir. en un mot on a voulu faire des fourmis de petits hommes plus parfaits que les grands auxquels on les a proposees comme des modelles a imiter. il eut ete assurement tres permis de faire des fourmis de petits animaux encore plus accomplis si on en eut besoin pour la composition d'une jolie fable et instructive; mais comme je pense qu'il n'etoit permis aux naturalistes que de nous les montrer telles que la nature les a faites ou plutot telles que nous pouvons les voir, on ne trouvera pas dans l'histoire que nous en allons donner des faits aussi propres a faire honneur a l'esprit et aux bonnes moeurs de ces petits animaux que ceux dont il vient d'etre parlé, et peut etre trop au long. mais pour dedomagement on y en trouvera de plus certains qui ont leur singularite, dont plusieurs n'avoient point ete observes et tres dignes de l'être.

les differentes especes de fourmis n'ont dans leurs formes que peu de differences remarquables a nous offrir. aussi quand on connoit bien la figure exterieure d'une fourmi on connoit assez celles des fourmis de toutes les autres especes. on n'en trouve point comme parmi les especes de tant d'autres insectes de propres a nous toucher par la beaute et l'eclat de leurs couleurs[7]*; la plupart des especes*



Facsimile of a manuscript page of the
Histoire des Fourmis

sont d'un brun de marron, d'autres sont tres noires, ou d'un noir violet; quelques unes sont rougeatres, et on les appelle rouges d'autres sont precisement de couleur d'ambre, mais on ne voit point, du moins n'ai-je jamais vu des fourmis d'un beau rouge, ni d'un beau bleu, ni d'un beau jaune, ni d'un beau verte. il y en a de blanches, ou presque blanches.[8] *celles de quelques especes ont par le corps des rayes transversales mais leurs especes different beaucoup entr'elles par la grandeur; les plus grandes fourmis, au moins les plus grandes fourmis d'europe ne sont cependant que d'assez petits insectes. Ray*[9] *n'en a observe en angleterre que cinq especes; les descriptions qu'il en a faites m'ont mis en etat de juger que les memes sont aussi en france, ou il est facile d'en trouver beaucoup plus d'especes. il m'en est venu des isles de l'amerique, et des grandes indes plusieurs especes que nous n'avons pas dans ce pays.*

c'est par leurs facons de vivre, et par leurs differentes inclinations qu'il est souvent plus aise, et toujours plus agreable de les distinguer les unes des autres.[10] *toutes sont nées pour la societe; il n'y a point dans le genre des fourmis, du moins n'en connois-je point, des especes dont les individus vivent solitaires, comme il y en a dans le genre abeilles, et dans celui des guespes.*[11] *mais les societes des fourmis de differentes especes se conduisent differemment. les unes comme les peuples policés ont des etablisements fixes; leurs fourmilleres sont en quelque sorte des villes a l'aggrandissement des quelles elles travaillent journellement. des fourmis de plusieurs autres especes n'ont que des etablisements passagers, elles peuvent etre comparees aux tartares. elles campent pour ainsi dire, elles sont toujours prestes a quitter le lieu ou elles s'etoient arrestees, des qu'il cesse d'avoir les commodites qui les avoient determiné a le choisir.*[12] *celui qui leur avoit ete convenable dans un temps sec cesse de l'etre quand la pluie tombe abondamment, elles l'abandonnent et abandonnent de meme le lieu ou elles s'etoient refugiees pendant des jours pluvieux, lorsque le temps s'est remis au beau.*

entre les fourmilleres de ce pays qui sont des habitations a demeure celles qui se font le plus remarquer par la grosseur de leur masse et par le nombre de leurs habitants, sont principalement com-

posees de brins de bois sec, mis les uns sur les autres, elles sont construites par des fourmis brunes de la plus grande des especes de notre climat[18]*; la plupart de ces fourmilleres sont exposees a toutes les injures de l'air. il y en a pourtant de placees au pied ou d'un gros arbre qui leur donne quelqu'abri d'autres le sont au milieu des bois. mais pour l'ordinaire on les trouve dans des endroits decouverts; il y en a beaucoup de posees au pied d'une haye qui ne scauroit guere que leur donner d'abri contre le vent du nord tres souvent elles sont surtout situees tres pres des grands chemins. mais la plupart se trouvent le long des chemins ou* [*aussi bien*] *aupres des hayes; la rien ne les met a couvert de l'eau qui tombe du ciel. les fourmis n'aiment pourtant pas a etre mouillees; aussi leur architecture, qui est simple, tend a empecher l'eau de penetrer trop facilement jusques au fond de l'habitation; elle tend aussi a y conserver une certaine humidite; nous verrons dans la suite que s'il est essentiel qu'elle ne soit pas inondee qu'il l'est dememe quelle ne soit pas trop dessechee par les rayons du soleil, quoiqu'il soit bon qu'ils contribuent a y entretenir de la chaleur. ce que les fourmis dont il s'agit scavent de mieux pour satisfaire en meme temps a ces differentes vues, c'est d'entasser les uns sur les autres de petits morceaux de bois mort et divers autres petits corps; c'est a quoy elles travaillent continuellement, aussi plus une fourmillere est ancienne et plus elle est elevee audessus de la surface de la terre. la plus grande partie de l'edifice est cependant enterree. elles ne lui donnent pas d'abord des fondements aussi profonds qu'il les a ensuite, a mesure qu'elles elevent la fourmillere, au moins pendant un certain temps, elles creusent la terre qui est audessous; pendant qu'elles elevent le faiste, elles poussent les fondations plus bas; on demandera comment cet edifice audessous duquel on creuse continuellement ne s'ecroule point pour en voir la raison on n'a qu'a degrader une fourmillere seulement d'un cote en laissant plus* [*de*] *diametre aux parties les plus elevees qu'a celles qui suivent; ce qui est plus eleve se soutiendra en l'air malgre sa saillie; on jugera donc que les differentes couches de brins de bois forment des especes de voutes capables de se soutenir par elles meme. en un mot la fourmillere est un edifice qui peut etre*

repris sous oeuvre des qu'on ne le reprend que partie a partie. il y en a dont le grand diametre horizontal a plus de trois a quatre pieds de diametre, et qui n'ont guere moins en hauteur depuis leurs fondements souterrains jusqu'a leur sommet. quand on defait en entier une de ces grandes et anciennes fourmilleres on est etonne de la quantite des materiaux qui s'y trouvent assembles; quoiqu'on sache que le nombre des petits insectes qui se sont reunis pour les transporter ait ete tres grand, et qu'on les sache des ouvriers infatiguables on a peine a concevoir qu'ils y aient pu suffire. la plupart des pieces ne sont que de petits brins de bois tantot plus menus, tantot plus gros, tantot plus longs, et tantot plus courts on en remarque avec surprise quelques uns d'une grandeur et d'une pesanteur qui ne permettent pas d'imaginer qu'ils aient pu etre conduits ou ils sont par des fourmis.

parmi les brins de bois qui font le gros de la masse on peut remarquer une grande quantite de differentes sortes de petits corps les uns sont longuets et tels sont des brins de paille, et divers brins d'herbe seche d'autres qui ont des figures plus courtes et plus arrondies sont tantot des graines de differentes plantes, ou de differents arbres telles que celles des hetres, des tilleuls, des ormes, ou des coques de graines, tantot ce sont des noyaux de petits fruits, comme de merisses, et des senelles, plusieurs de ces petits corps sont de petites pierres plattes. en un mot les fourmis regardent comme des materiaux propres a entrer dans la construction de leur logement, touts les petits corps qui ne sont pas trop dissolubles a l'eau, et elles emploient ceux que leur offrent les environs du terrain ou elles se sont etablies. j'ai vu de tres grosses fourmilleres scituées assez proche d'une longue allee de maronniers d'inde qui n'etoient presque composees que des queues des feuilles de ces arbres. ces queues sont si longues et meme si grosses par rapport aux brins de bois dont sont faites les autres fourmilleres que si on regarde ces dernieres comme construites de petites solives, les autres le sont de tres grosses poutres.

je prouverai encore qu'elles se determinent a employer les materiaux qui se trouvent le plus sous leur main par une observation que je fis

une année dans la plaine des environs de thouars en poitou. sur les bords de plusieurs champs, je vis des fourmilleres dont le volume n'etoit pas bien considerable quelques unes n'etoient gueres plus grosses que le point, et les plus grosses n'avoient qu'une ou deux fois plus de diametre que celles ci. aussi etoient elles habitees par des fourmis d'une grandeur mediocre.[14] *toutes ces fourmilleres etoient uniquement composees de grains d'orge. j'ai passes plusieurs fois depuis dans les memes endroits et dans la meme saison sans avoir vu de fourmilleres faites de pareils grains dans une année ou ils avoient été receuillis trop secs il en etoit apparemment tombe beaucoup par terre, et rien n'avoit paru plus commode a des fourmis que de s'en servir pour se faire leur habitation.*

le choix des materiaux n'est pourtant si indifferent aux fourmis de toutes especes il y en a qui batissent leur fourmillere de grumaux de resine[15]*; si la resine leur manquoit elles ne croïroient pas trouver un equivalent dans les brins de bois. ce que* Mr. *Scullens nous a dit de ces fourmilleres baties de resine dans sa description imprime a leipsic en 1720 du terrain des environs d'ienne, merite detre rapporte ici. il nous apprend que les fourmis qui se sont etablies dans les forests de pin, se chargent des grumeaux de la resine qui a decoule de ces arbres, qu'elles les portent sous terre ou elles en font des tas; qui sont souvent cachés a plus de quatre pieds de profondeur. quoique la resine n'y ait ete portee qu'en petits morceaux, et secs la chaleur fait par rapport a ces morceaux ce que fait le froid par rapport a la glace pulverisee qu'on a jette dans une glaciere. elle les reunit en masse. on ne doit point etre embarasse a expliquer comment il peut regner a quatre pieds sous terre une chaleur capable de ramollir, et rendre un peu coulante de la resine des que c'est dans un lieu habite par un grand nombre de fourmis. les femmes des paisant vont chercher ces fourmilleres, pour en tirer des masses de resine qu'elles vendent pour de l'encens et qui est appele l'encens des thuringiens thus thuringorum. ce que la chaleur des fourmis fait evaporer de cette matiere et ce qui s'y joint du volatille qui transpire de leur corps peut faire que cette resine soit autrement conditionnée quand on la tire de terre que quand elle y a ete portée.*

M. Elshotius,[16] *dans les ephemerides de curieux de la nature de cennio 1° anno 9. pag. 229 nous a aussi parlé de la resine qu'on trouve dans des nids de fourmis qui sont en grand nombre dans les forests de pins sauvages (pinastri), de la marche de brangdebourg et ce qu'il en dit donne lieu de juger que cette resine y a recu quelqu'alteration avantageuse tant par rapport a l'odeur que par rapport a la durete, il rapporte qu'on la vend a des ignorants pour de la myrrhe, ou pour du succin. pour la vendre pour autre chose que de la resine ordinaire meme a des ignorants, il faut qu'elle en differe. celle dont il s'agit ne se trouve que par grains mesles des brins de paille et de bois. Mr. Elshotius releve Kentmannus qui sembloit avoir pense que la resine etoit convertie en succin dans les fourmilleres de la marche de Brandebourg.*[17]

d'autres fourmis dont les etablisements sont fixes n'aiment a se tenir ni sous terre, ni meme immediatement sur la terre; pour l'ordinaire elles se logent dans l'intérieur des arbres qui sont pourris en partie; le lieu meme qu'elles ont choisi leur fourni les materiaux dont elles batissent, elles n'ont pas besoin de rien apporter de dehors. elles rongent du bois prest a tomber en pourriture, et le mettent en oeuvre d'une maniere qui sera expliquee dans la suite.

toutes celles d'europe sont des ouvrieres en petit, en comparaison de celles de quelques especes des indes occidentales; s'il n'y a rien d'exagere dans ce que les voyageurs nous rapportent de leurs edifices ils surpassent autant par leur grandeur ceux des autres fourmis, que les piramides d'egypte surpassent par la leur les autres monuments anciens. des tas de terre rapportee grain a grain dont la grandeur egale celle d'un tonneau ch. ovius cite par jonston[18] *pag. 88. sont rellement par rapport aux fourmis des ouvrages comparables à ces fameuses piramides.*

nous avons dans ce pays differentes especes de fourmis qui ne batissent qu'avec de la terre dont elles attachent les grains les uns contre les autres; mais elles sont bien eloignees d'en reunir assez ensemble pour former des tas qui approchent du volume de ces immenses fourmilleres des indes. les plus grosses des leurs egalent a peine ces tas (de) terre qui sont l'ouvrage des taupes. en certaines

provinces du Royaume, comme dans quelques cantons du maine, on a cependant lieu de se plaindre de leur grosseur et encore plus de leur nombre; elles gatent les prés a un point qui engage ceux qui les afferment de metre pour une des conditions du bail qu'on sera oblige chaque annee d'abbatre les fourmilleres, d'applanir les endroits ou elles se trouvent.

rien n'est plus ordinaire en tout pays que voir des fourmis de plusieurs especes de differentes grandeurs qui fouillent la terre, et qui portent sur la toufe de plante la plus proche de l'endroit ou elles creusent chaque grain de terre qu'elles ont detache elles [en] recouvrent les feuilles et ses tiges.[19]

parmi celles qui ne se chargent que de grains de terre il y en [a] qui aiment a metre a couvert les masses qu'elles en font. j'ai vu souvent dans les mois de may et de juin sous le pied creux de la plupart des vases a fleur un establisement de fourmis; d'autres font le leur sous des caisses.

mais d'autres especes de ces insectes se logent sous la terre la plus compacte. elles creusent au dessous de sa surface des chemins tortueux qui se croisent les uns les autres, et qui penetrent souvent a un pied ou deux de profondeur. ces conduits souterains sont leurs logements, il ne leur en faut pas de plus recherchés; les fourmis peuvent souvent y arriver par trois a quatre trous differents qui en sont les portes. sur les bords de ces trous on voit des entonnoirs de terre, faits de celle qu'elles ont ete obligees de transporter pour ouvrir des cavites assez spacieuses.

celles qui se tiennent simplement dans des conduits tortueux creuses sous terre, et celles qui ne font leurs fourmilleres que de grains de terre entasses, ont des habitations ou elles se trouvent bien tant qu'il fait beau mais qu'elles sont obligees d'abandonner quand les pluies deviennent abondantes et continues; pour n'etre pas innondées elles demenagent; elles scavent trouver dans des murs des trous ou elles n'ont pas a craindre d'etre noyees; elles s'y refugient et s'y etablisent, elles en sortent dans les heures ou il ne tombe plus d'eau pour aller chercher a la campagne de quoy vivre; enfin quand la terre s'est ressuiée et qu'elles peuvent se promettre une suite de beaux

jours, elles songent a se faire un nouveau logement plus a leur goust que celui ou elles ont ete forcées de se tenir; elles vont en batir un de grains de terre, ou sous terre. au moyen de l'activite avec laquelle elles y travaillent, et de l'adresse avec la quelle elles remuent la terre elles ont en moins d'une journée une fourmillere ou elles peuvent etre a l'abri des rayons du soleil et qu'elles aggrandissent et rendent plus epaisse et plus solide dans la suite. elles se retirent de celle ci comme elles ont fait de la premiere, quand elles en sont chassées par la pluie; ainsi dans une annee et surtout dans une annee pluvieuse elles sont dans la nescesite de changer bien des fois de domicile, et de s'en construire succesivement un assez grand nombre.*

celles de toutes les especes sont plus admirables par l'ardeur avec la quelle elles travaillent que par les ouvrages meme qu'elles ex[e]cutent l'architecture de toute fourmillere est extremement simple et grossiere. apres avoir lu les descriptions faites par les anciens de l'interieur de chacune de ces sortes d'habitations on croiroit devoir trouver des divisions dans le goust de celles de nos grands batiments. ils y ont distingue plusieurs parties destinees a differents usages.[20] *selon eux la premiere et la plus spacieuse est le logement du peuple des fourmis la seconde partie est pour ainsi dire l'appartement des dames gynaeceum c'est la que les femelles se doivent tenir avec leurs petites familles. ils ont place les greniers a la porte de cet honorable appartement. enfin quelques uns ont mis le cimetiere immediatement apres les greniers. tout ce qu'il y a de reel dans cette distribution de laquelle il faut en largement suprimer les greniers, et le cimetiere, c'est qu'ordinairement le gros des fourmis se trouve plus pres du haut de la fourmillere, que ne le sont les petits insectes qui en sont l'esperance et qui ne sont pas encore des fourmis. mais on se feroit une fausse idée si on y imaginoit de grandes places comme celles des villes, ou des especes de salles immenses par rapport au total de l'edifice, dans lesquelles les fourmis se rassemblent. si pour nous en faire une idee plus juste nous voulons comparer les fourmilleres a des villes dont la grandeur est proportionnée a la taille et au nombre des citoyens, ce sont des villes qui ne sont com-*

* *Exp. forcer de ces fourmis a se faire leurs fourmilleres.*

posées que de rues couvertes, ou si nous nous contentons de comparer les fourmilleres a des edifices destines a contenir beaucoup d'habitants; (elles) sont uniquement composes d'escaliers qui se croisent les uns les autres et les endroits les plus spacieux de chaque fourmillere sont tres petits et peuvent etre compares au pailliers des escaliers. c'est donc dans les rues, a la verite couvertes, et dans des escaliers ou leurs palliers que les fourmis habitent et tantot plus haut et tantot plus bas selon l'etat de l'air. tant de chemins qui se croisent ont paru a Olien[21] *dignes d'etre mis en parallele aves les routes des fameux labirintes mais les routes n'ont pas ete multipliees dans les fourmilleres pour egarer les fourmis, elles l'ont ete pour qu'elles puissent en quelqu'endroit qu'elles soient en trouver une qui conduit en haut et en bas, et une qui mene a droite et a gauche et d'autres qui menent de tous les autres cotes.*

on pourroit cependant soupconner que les fourmilleres et surtout celles qui sont faites d'un si prodigieux nombre de petits morceaux de bois ont dans leur interieur des singularites caches a nos yeux; qu'on derange ce que la disposition de ces morceaux de bois a de plus digne d'etre vu lorsqu'on de fait une fourmillere pour l'examiner depuis sa surface superieure jusques a ses fondements. pour en voir une dans toute sa hauteur, et pour voir aussi avant dans son interieur qu'on peut l'esperer et peut-etre autant qu'on a besoin d'y voir, j'ai oblige des fourmis a construire la leur sous mes yeux dans un vase transparent. apres avoir ajuste un couvercle d'un epais carton a une des plus grandes cloches de verre avec lesquelles on couvre les plantes des couches; je jettai dans cette cloche les fourmis que je prenois a poignee dans une fourmillere tres peuplée, et dans un moment ou elles etoient peu en mouvement. outre les fourmis je mis dans la cloche une partie des materiaux qu'elles avoient rassemble apres que la cloche eut ainsi ete remplie jusqu'a plus des deux tiers de sa hauteur, je lui donnai son couvercle au moyen duquel les fourmis se trouverent prisonnieres; le nombre de celles qui furent renfermées surpassoit beaucoup le nombre de celles qui m'avoient echape. elles commencerent comm'elles le devoient par tout tenter pour sortir d'un lieu ou elles etoient contre leur gre; mais n'aiant

pu trouver aucune issue au bout de quelques heures elles parurent avoir pris leur parti; quelques unes commencerent a remuer des brins de bois, a chercher a les mieux ajuster, enfin dans les jours suivants elles se livrerent tout de bon au travail. comme mon intention n'etoit pas de les laisser perir de fatigue et de faim je ne manquai pas de leur fournir en abondance les Aliments que je scavois etre les plus a leur goust. j'avois menage une porte au couvercle par la quelle je faisois passer ceux que je voulois leur jetter. enfin je fis tout ce qui etoit en moy pour qu'elles n'eussent a regreter que leur liberte, aussi ne parurent elles pas se trouver mal de leur prison. outre les brins de bois qu'elles avoient d'abord a leur disposition je leur en donnai d'autres dans la suite je ne les laissai pas plus manquer de materiaux pour bastir que de vivres, aussi se firent elles une fourmillere semblable a l'exterieur a celle qu'elles avoient habitee auparavant, et qui l'etoit apparement dans l'interieur; celui ci n'offroit que des routes tortueuses dont les unes plus larges pouvoient etre comparees a nos grandes rues et les plus frequentees, et les autres plus etroites ne pouvoient l'etre qu'a nos petites rues.

par un expedient semblable j'ai aussi fait travailler a portee de mes yeux des fourmis de quelques unes des especes, qui se tiennent sous terre. j'ai renferme toutes celles d'une meme societe dans un tres grand vase d'un verre blanc et bien transparent fait en forme de gros flaccon, et plein de terre d'amouce [sic]. au bout de quelques jours il a ete presque rempli par cette meme quantite de terre, et cela parce que les fourmis qui fouilloient dans l'interieur de la masse apportoient les unes apres les autres sur sa surface superieure les grains de terre qu'elles detachoient; toute la terre qui etoit tres compacte parceque je l'avois pressee, fut rendue bien autrement meuble que n'est celle que les jardiniers ont passe par les clayes les plus serrees. des routes digerees [dirigées] en divers sens, mais qui toutes tendoient vers le fond du vase, etoient encore tout ce qu'on voioit de remarquable dans l'interieur, quelques unes se trouvoient sur les parois meme du vase, mais aucune ne descendoit en ligne droite.

les fourmilleres qui paroissent construites avec le plus d'art sont

celles qui sont faites d'une terre tenace, et celles qui le sont de sciure de bois presque pourri.[22] *les unes et l'autres sont composees d'un grand nombre de plaques ou lames ceintrees destinées a couvrir des cavites distribues par etages mais assez irregulierement. on ne peut comparer la masse totale a rien a quoy elle ressemble davantage qu'a une eponge, mais dont les vuides sont encore plus grands que ceux des eponges les plus grossieres. aucune de ces cavites n'est aveugle elles communiquent toutes les unes avec les autres. elles sont de grandeurs fort inegales dans la meme fourmillere quelquefois les fourmis peuvent entrer dans une des plus grands par cinq ou six des plus petites, et en sortir pour descendre plus bas par autant d'autres petites cavites. les fourmilleres dans la construction des quelles de la sciure de bois a ete emploiee forment quelque fois des masses assez considerables, et qu'on prendroit et que j'ai vu prendre meme par des phisiciens pour de gros morceaux de bois qui avoient ete perces en tout sens et comme cribles par les fourmis. rien aussi ne doit mieux imiter le bois qu'une paste faite de grains de bois pourri en partie. les fourmis humectent les grains qu'elles ont detaches avec une liqueur propre a les coller ensemble.*[23] *elles attachent la petite masse qu'elles ont formée de grains ainsi reunis, contre de plus grosses masses.*

ces dernieres fourmilleres doivent etre a couvert c'est pour l'ordinaire dans des troncs d'arbre dont le coeur est pourri qu'on les trouve, on en voit aussi quelquefois au pied meme des arbres sous leurs racines. ce qui est essentiel aux fourmis qui les batissent c'est d'avoir dans les environs du bois plus aise a reduire en scieure que ne l'est celui qui est sain. l'espece du bois semble leur importer beaucoup moins; dans les forests elles font leurs etablissements dans les chesnes, et j'en ai vu qui dans mon jardin avoient fait le leur dans des marronniers d'inde creux; j'ai pu meme suivre de celles ci pendant qu'elles travailloient a aggrandir leur fourmillere; elles mettent ses fondements sur le fond ou tout pres du fond de la cavite et elles s'occupent journellement a l'elever, ce qui va assez lentement. quelquefois dans deux ou trois semaines elles n'augmentent la hauteur que d'un pouce ou deux. le dessus de celle que

je pouvois observer etoit toujours couvert d'une couche de poudre ou scieure de bois epaisse pour le moins de cinq a six lignes dont les grains n'etoient nullement adherents les uns aux autres. cette couche est l'amas des materiaux qui doivent etre mis en oeuvre, pendant que les unes prennent des grains a sa surface inferieure pour en faire la pate dont elles forment successivement les differents ceintres qui entrent dans la composition de la fourmillere, d'autres sont occupees a apporter d'autres grains, et a les deposer sur la surface superieure afin que la provision de materiaux ne s'epuise pas.

les ruches vitrees[24] *dans les quelles je tiens des abeilles m'ont donne la facilite de mieux voir l'interieur des fourmilleres faites soit d'une paste de bois, soit d'une paste de terreau, que je n'eusse ose l'esperer s'il m'eut fallu chercher les moyens d'y parvenir. des fourmis de differentes especes tentent chaque année de profiter de la chaleur que les abeilles entretiennent dans leur habitation. les carreaux de verre de ces ruches sont couverts par des volets qu'on n'ouvre que quand on veut se donner le plaisir de voir travailler ce qui se passe dans leur interieur. entre ces volets et les carreaux il reste toujours du haut en bas une distance souvent de plus d'un pouce. des fourmis croyent ne pouvoir mieux faire que de profiter d'un vuide ou elles peuvent jouir constamment d'une chaleur douce.* j'y ai souvent trouve des societes extremement nombreuses dont les unes se contentent d'apporter et d'entasser des grains de terre et dont les autres travaillent en paste soit de terre soit de bois. et j'ai vu un[e] de ces societes tres nombreuses, et fournies de fourmis de tout age entre des volets de ruches ou je n'avois loges que depuis deux jours [des abeilles]. les connoissances de ces insectes, s'ils ont des conoissances, ne vont pas jusques a scavoir que ces volets et ces carreaux si commodement disposés n'ont pas ete mis la pour eux; ils ne prevoyent pas que leurs etablissements ne scauroient etre de longue duree que tout y sera boulversé par le premier curieux qui viendra ouvrir les volets. elles pourroient encore moins prevoir qu'il sen presenteroit quelqu'un qui fache des derrangements qu'il auroit cause parmi eux ne son-*

* *ce que deviennent l'hiver celles des ruches, il ne semble pas qu'elles puissent trouver mieux, cependant elles n'y restent pas.*

geroit comme je l'ai fait qu'a leur assurer de la tranquillite a la seule condition qu'il lui seroit permis de les observer de temps en temps. j'ai arreste un carreau de verre en dehors de la ruche, a fleur de l'endroit ou se trouvoit la surface d'un volet fermé. ainsi le nid a ete renfermé entre deux carreaux, et n'etant plus appuie contre le volet on pouvoit ouvrir celui ci sans derranger aucunement les travaux des fourmis. autraver d'un verre bien transparent on observoit aisement a quoy elles etoient occupees. rien n'etoit cache de l'interieur d'un nid si mince et plein de cavites disposées par etages, on le voioit enfin dans toute son epaisseur, et du haut en bas.[25]

au lieu de se faire avec de la paste de bois des logements qui ressemblent a des eponges, commes les font les fourmis dont nous venons de parler, d'autres s'en construisent assez semblables a ces derniers en criblant des morceaux d'un bois tendre. comme il y en [a] qui se contentent de percer en terre des sentiers qui se croisent, il y en a de meme qui en percent dans des bois a moitie pourris. j'ai eu par exemple de vieux bancs de jardin ou les fourmis s'etoient etablies en grand nombre.

feu Mr. Raoul, conseiller au parlement de bordeaux, capable de faire des observations, et qui me communiquoit volontiers celles qu'il avoit faites, m'a entretenu dans une de ses letres de fourmis blanches[26] *de la grandeur des plus communes que je n'ai jamais eu occasion de voir, et dont il vit a la fin du mois de may qui suivit l'hiver de 1709 une quantite prodigieuse. cet hiver qui causa tant de pertes a une grande partie de l'europe fit perir les pins des landes de Bordeaux. Mr. Raoul eut a en faire abbatre plus de 2000 de ceux qui lui etoient morts. un esprit de curiosite le porta a enlever l'ecorce de quelques uns, et ensuite d'un tres grand nombre de ces arbres parcequ'il trouva dans touts entre l'ecorce et le bois des milliers de fourmis blanches qui tenoient dans une espece de poudre presqu'aussi fine que du tabac d'espagne. il ne put decouvrir aucune de ces fourmis sous l'ecorce des arbres de differentes autres especes qui avoient peri par la rigueur du froid du meme hiver.*

il y en a des especes pour qui la tete d'un chardon est ce qu'un

tres gros arbre est pour d'autres. Mr Bonnet[27] *en trouva de rouges, fort petites qui avoient fait leur etablisement de la tete d'un chardon a Bonnetier; et qui se presterent au plaisir qu'il voulut se donner de les avoir sous les yeux dans son cabinet apres avoir coupe la tige du chardon en laissant sept a huit pouces de long a la portion a laquelle la tete tenoit, il piqua le bout inferieur de cette portion de tige dans la terre dont il avoit rempli un verre; il placa ce verre ou ce qui est la meme chose cette fourmillere dans son cabinet ou elle resta pendant pres d'un mois avec son petit peuple parce qu'il eut soin de pourvoir a toutes les commodites.*

apres avoir pris une idee suffisante des varietes que peuvent offrir les habitations des fourmis des differentes especes, nous devons voir a quoy ces habitations leurs servent, a quoy elles s'occupent dans leur interieur, a quelles intentions elles les quittent pour parcourrir la campagne, et comment elles se perpetuent; enfin nous devons voir comment chaque fourmi passe une vie qui est toujours tres occupée; car elles ne cessent d'etre en action que dans les temps ou le repos leur est devenu nescesaire. aussi sont elles dignes de touts les eloges qu'on leur a donnes par rapport a leur amour pour le travail; mais comme nous l'avons deja dit il y a plusieurs annees, on les a louees d'une prevoyance qu'elles n'ont pas parce qu'elle leur eut ete inutile. on a cru de tout temps que rien ne les occupoit davantage pendant l'ete que le soin de faire des magazins de grains pour se nourrir pendant l'hiver. on les a citees comme propres a remplir de confusion ceux qui ne scavent pas s'inquieter assez de l'avenir. la charmante fable de la fourmi et de la cigale n'en est pourtant pas moins instructifve, quoiqu'il soit certain que la fourmi ne scait point faire de provision pendant l'ete, et quoique toutes les cigales soient mortes chaqu'année longtemps avant que l'hiver arrive.[28]

pour en venir a degrader les fourmis; pour leur ravir une gloire dont elles etoient en possession tranquille de temps immemorial; il a fallu que j'y aie ete force par des preuves auxquelles il n'y avoit rien a repliquer.[29] *j'ai du etre curieux de voir ces magazins bien fournis dont on leur a fait tant d'honneur. pour les decouvrir j'ai*

fait fouiller dans les differentes saisons de l'année dans un grand nombre de fourmilleres, bien plus bas que l'endroit le plus bas ou elles se tiennent j'ai fait fouiller jusques dans les endroits ou il ne paroissoit dans la terre aucun sentier tracé. j'ai fait fouiller de meme dans les environs de la fourmillere et ca toujours ete inutilement jamais je ne suis parvenu a decouvrir ce lieu ou sont mis en reserve touts ces grains dont elles se doivent nourrir pendant l'hiver. je connois plusieurs personnes qui curieuses comme moy de trouver ces greniers sous terrains les ont cherche inutilement.

il n'est presque pas permis de soupconner que des amas aussi considerables que ceux qu'on leur a cru nescesaires, eussent echape a tant de recherches; d'ailleurs je n'ai pas manque de les etudier les fourmis dans les temps ou elles devoient etre le plus occupées au transport des grains; quelqu'art qu'elles eussent eu pour cacher leur marche, il n'etoit pas possible que je ne fusse parvenu a voir ou elles alloient les metre en depot. mais la fin pour laquelle elles feroient de ces pretendus amas ne leur permetroit pas de les loger ailleurs que dans la fourmillere meme; on veut qu'ils soient la provision nescesaire pour faire vivre les fourmis pendant l'hiver; or tant que le froid dure elles se tiennent closes et couvertes vers le fond de leur habitation; elles n'en sortent point. si elles avoient besoin d'avoir alors des magazins de bled ils devraient donc etre aupres d'elles. c'est aussi dans la fourmillere qu'on a place ces greniers que j'ai cherche inutilement dans plusieurs que j'ai decouvertes en hiver, et jusqu'au fond des quelles j'ai fouille; je n'y ai jamais trouve ni des grains sains, ni des debris de grains manges.

mais enfin tout l'art qu'on voudroit leur soupconner pour cacher leurs magazins eut ete inutile a celles que j'ai tenues dans de grandes cloches de verre. j'ai deja dit qu'elles n'avoient rien neglige pour s'y metre a leur aise, qu'elles s'etoient fait avec les brins de bois, et les autres petits corps que j'avois mis a leur disposition une fourmillere semblable a celle qu'elles avoient habite auparavant, et telle que toutes celles qui sont construites en pleine campagne; la elles faisoient tout ce que des fourmis scavent faire. il ne tint qu'a elles de se procurer avec peu de peine les magazins les mieux remplis de

grains. dans differentes saisons de l'année, au printemps, en ete, en automne, j'ai jette des grains de froment bien conditionnes sur leur fourmillere; elles n'avoient qu'a s'en charger, le chemin qu'elles avoient a leur faire faire n'etoit pas long soit qu'elles voulussent les metre en tas dans la fourmillere, soit dans la terre qui en faisoit le fond. mais elles les ont laisses pour la plupart ou je les avois fait tomber, elles n'ont deplacé que ceux qui embarassoient les passages, enfin elles ne les ont point transportes dans l'interieur de leur habitation.

on ne s'est pas contente d'assurer qu'elles faisoient des provisions de grains de bled, on a pretendu de plus qu'elles avoient le secret d'empecher que ces grains quoique deposes dans un lieu humide ne fussent en risque de se gater qu'afin qu'il ne leur arrivat pas d'y vegeter elles ne manqueroient pas de leur couper a chacun le germe.[30] *les fourmis de ma cloche ne firent pas meme usage de leur art pour conserver les grains qui etoient a leur disposition; aussi n'y resterent ils pas longtemps sans germer; ils pousserent ensuite des feuilles comme ils eussent fait s'ils eussent ete semes dans une bonne terre.*

si les fourmis avoient besoin de scavoir se faire des magazins, et de scavoir conserver les grains qu'elles y auroient mis elles les scauroient sans doute, et y travailleroient; mais ces connoissances leurs seroient aussi inutiles qu'elles le sont a des insectes de tant d'autres genres qui passent tout l'hiver sans prendre aucun aliment. des que les froids deviennent assez grands pour empecher les fourmis de courir la campagne, elles se tiennent tranquilles dans l'habitation qu'elles se sont preparee, elles y sont entassees les unes sur les autres sans se donner aucun mouvement je les ai toujours trouvees en cet etat dans le fond de leurs fourmilleres lorsque je l'ai mis a decouvert pendant l'hiver. mais lorsque dans de beaux jours, les Rayons d'un soleil brillant echaufent jusqu'a l'interieur de la fourmillere, elles se raniment, elles sortent de chez elles et vont faire des courses qui ne sont pas aussi infructueuses que le seroient dans une saison encore peu avancée celles des abeilles. celles ci ont besoin d'avoir du miel en provision lorsqu'elles chercheroient inutilement les fleurs

d'ou elles scavent le tirer mais en toute saison la campagne offre aux fourmis differentes sortes de mets a leur goust.

il est pourtant singulier que ces grains de bled dont on voulu qu'elles fisent leur provision soient precisement une des productions de la terre dont elles ne se nourrissent pas, il n'y a peutetre jamais eu un grain de bled entamé par une fourmi. elles ont laisse sains et entiers ceux que j'ai jettes sur les fourmilleres renfermees dans des cloches de verre qu'on ne croie pas au reste que si elles n'y touchoient que c'etoit parce que je les fournissois abondamment d'aliments qui leur etoient plus agreables. j'ai fait une experience qui m'aprouve que la plus grande nescesite ne pouvoit les forcer a vivre de bled. je renfermai dans un poudrier[31] *des fourmis d'une fourmillere construite de petits batons et je leur donnai des mets que je scay qu'elles aiment sans leur donner d'ailleurs ce qui leur falloit pour se construire un logement. dans un autre poudrier je mis des fourmis de la meme fourmillere, a peu pres en meme quantite et prises dans le meme moment; et je ne leur offris pour se nourrir que beaucoup de grains de froment. en peu de jours toutes les fourmis de ce second poudrier perirent, et il est plus que probable que ce fut de faim; car touts grains furent trouves tres entiers; il n'y en avoit aucun qui parut meme avoir soufert un coup de dents. les fourmis du premier poudrier qui avoit toujours ete tenu a cote du second, etoient alors tres vivantes, vecurent encore plusieurs jours, quoiqu'elles n'eussent pas de nid, et peutetre m'eut il ete possible de leur faire pousser loin leur vie si j'eusse voulu continuer d'en prendre soin.*

sur quel fondement donc a t-on assuré que les fourmis se font des magazins et qu'elles ne manquent pas de couper le germe aux grains qu'elles y accumulent. c'est qu'on les a vu reellement transporter des grains de bled, et qu'on a vu de ces grains rester sur leur fourmillere ou ils ne germoient pas. on a conclu de ces faits plus qu'on n'en devoit conclure. on a cru que la fourmi qui transportoit un grain de bled se proposoit une fin differente de celle qu'elle avoit lorsqu'elle se chargeoit d'un brin de bois ou d'une tres petite pierre, ou d'un grumeau de terre; les grains de bled comme le brin de bois,

comme la petite pierre, comme le grumeau de terre etoit neantmoins destine a entrer dans la construction de la fourmillere. plusieurs grains pareils y peuvent etre emploiés, nous avons meme rapporte ci devant que nous avions vu de petites fourmilleres dont les seuls materiaux etoient des grains d'orge les uns etoient pesants, c'est a dire bien conditionnes, et les autres tres legers; je fouillai dans la terre qui etoit couverte par ces grains, et dans laquelle ces fourmis penetroient, elles n'y en avoient pas enfoui un seul. elles auroient pourtant bien eu de quoy y en remplir de beaux magazins. s'il arrive souvent aux grains de bled qu'elles ont portes chez elles de ne point germer, c'est qu'elles prennent par choix les plus legers, et par consequent ceux qui sont les plus mal conditionnes, dont l'interieur est pourri et qui n'eussent pas pousse quand meme ils eussent ete fermes dans une bonne terre. touts ceux qu'elles voiturent ne sont pourtant pas si mauvais, elles se chargent de ceux qui sont pesants quand elles n'en trouvent pas de legers. aussi ai je vu plus d'une fois a la fin de septembre ou en octobre du bled leve, et deja assez haut autour d'une fourmillere scitue pres d'un champ ou on en avoit fait une bonne recolte dans le mois d'aoust.

en general les graines qui ne contiennent qu'une substance farineuse seche et insipide ne sont pas du goust des fourmis, elle n'ont pas tenu plus de compte de grains d'orge de segle d'avoine, que je leur ai offerts que de ceux de froment, elles ont de meme meprise des graines de laitue, de chicoree et autres; elles aiment comme nous les fruits pleins d'eau, et surtout d'une eau sucree. nous n'apprendrons a personne qu'elles sont tres avides de sucre et liqueur sucrees; on scait qu'on est tres embarasse a defendre contr'elles, surtout a la campagne, les confitures et les compotes; quand quelqu'une est heureusement parvenue a decouvrir l'office ou on les met, a penetrer dans l'armoire ou on les renferme, elle ne tarde gueres apparement a en avertir ses compagnes. on voit alors du matin au soir une file continue et bien fournie, de fourmis qui vont au pillage. la longueur du chemin qu'elles peuvent avoir a faire ne les etonne pas quelqu'eloigne que soit l'office du jardin, et par consequent du lieu de leur etablisement elles s'y rendent pour s'y rassasier de fruits qui sont

plus penetres de sucre que ceux que la nature leur offre, elles montent a un premier a un second a un troisieme etage, et plus haut s'il en est besoin. quelque chose qu'on tente on ne vient point a bout de les derouter; et quelque nombre qu'on en tue on ne voit pas diminuer sensiblement celui des vivantes qui ne sont pas instruites du sort funeste de celles qui les ont precedees. on ne peut alors sauver ses compotes, et ses confitures qu'en les changeant de lieu, ou qu'en les mettant dans des armoires presque fermees hermetiquement; ou enfin en faisant en sorte que pour arriver a chaque pot ou a chaque compotier elles aient un grand etang a traverser c'est ce qu'on fait en mettant chaque vase dans une assiette ou dans un plat plein d'eau.

toutes les especes de fourmis n'ont pourtant pas un goust si decide et si vif pour le sucre, les plus grosses de ce pays, celles qui batissent avec des brins de bois ne viennent point piller les preparations que nous en avons faites. aussi ont elles tenu peu de compte des morceaux de sucre que j'ai jetes sur leurs fourmilleres; quand ils ont disparu au bout de plusieurs jours ca ete parce qu'ils s'etoient fondus, et non parce qu'ils avoient ete manges.

un motif semblable a celui qui conduit les fourmis de diverses especes soit tres petites, soit de mediocre grandeur, dans nos maisons, les fait monter a la cime des plus hauts arbres[32] *sur la tige du chesne le plus eleve paroissent souvent des files assez larges, et non interrompues dont les unes ne sont presque composées que de fourmis qui montent et les autres que de celles qui descendent. ces files sont quelquefois continues depuis le pied de l'arbre jusques a l'extremite des dernieres branches. il n'est point dans la campagne d'especes d'arbres sur quelqu'uns desquels on ne voie des fourmis aller ainsi comm'en procession. on y voit aussi de ces processions sur des plantes de toutes especes; et on les voit de meme sur les plantes et sur les arbres de nos jardins. les jardiniers sont persuades qu'elles font beaucoup de mal aux arbres comm'aux peschers et aux abricotiers sur les quels elles paroissent en grand nombre. aussi ceux qui cultivent des oranges tentent beaucoup de moyens pour les empecher de monter sur les arbres pour qui elles ont pris goust. l'expedient qui reussit le mieux est le meme dont on se sert pour conserver*

contr'elles les confitures. quand la caisse de l'oranger est soutenue par des pieds soit en forme de boule, soit autres, on pose chacun de ses pieds dans un vase plein d'eau.

mais les fourmis scavent souvent se jouer des precautions qu'on a prises contr'elles. un temoin oculaire aussi respecte qu'aime de toute l'europe, pour la prolongation des jours duquel toutes les nations font des voeux de concert avec les françois qui ne craignent rien tant que la fin du plus doux et du plus sage des ministeres dont il est fait mention dans leur histoire; Mr. le Cardinal de Fleuri,[33] *apres m'avoir dit qu'il avoit toujours ete grand admirateur des fourmis, m'a racconte qu'il en avoit observe qui etoit parvenues a se faire un pont sur l'eau du vase dans le quel etoit pose un pied de caisse d'oranger qu'elles transporterent sous [ses] yeux de petits brins d'herbe seche, et de petits brins de bois, et que les aiant disposes les uns aupres des autres depuis le bord du vase jusqu'a la caisse, elles pouvoient se rendre a celle ci a pied sec. il m'a assure en avoir vu encore qui eurent recours a un expedient assez semblable dans un autre cas. pour les arrester on avoit mis autour de la tige de l'arbre une ceinture de glu, qui rendoit le chemin impracticable. pour le raccommoder elles travaillerent a y faire une chausee, elles apporterent et mirent les uns aupres des autres des grains de terre, des grains de sable et meme de petites pierres. apres quoy elles se trouverent [en] etat de franchir le mauvais pas.*

dans les livres de jardinage on donne comm'un secret pour les empecher de monter au haut d'un arbre d'en entourer la tige d'une simple ceinture de craye. il est vray qu'il arrive aux premieres fourmis qui tentent le passage de culbuter, les grains qu'elles saisisent ne sont pas assez adherents pour resister a leur poids, ils se detachent. mais les chuttes ne sont pas fatales a des insectes si legers. il y en a tant qui veulent passer, et la meme fourmi se presente tant de fois, que touts les grains mobiles sont emportes, et ce qui reste de craye est ferme, et ne les arreste plus.

apres tout quand [il y] auroit des expedients pour les empecher de monter sur les arbres ou elles se rendent en plus grand nombre, d'y avoir recours seroit une peine inutile. si les arbres sur les quels

elles se rendent paroissent quelquefois soufrir, on ne doit pas s'en prendre a elles elles ne cherchent aucunement a les entamer. mais elles scavent qu'il y a sur ses arbres des insectes d'especes differentes de la leur qui travaillent pour elles; qu'on suive les fourmis jusqu'au terme ou elles s'arretent, la on decouvrira soit sur les feuilles soit sur les branches des pucerons, ou des gallinsectes. j'ai dit aussi ailleurs que je n'avois pas eu de meilleurs guides pour decouvrir de nouvelles especes des uns ou des autres que les fourmis.[34] *les pucerons jettent par leur derriere, et par deux tuyaux qui en sont proche une liqueur sucrée dont elles sont avides. une pareille liqueur s'epanche peutetre de divers endroits du corps des gallinsectes, les fourmis les lechent volontiers, enfin les pucerons et les galles insectes occasionnent un epanchement de liqueur dont les fourmis profitent c'est ce qu'on peut voir dans l'histoire que nous avons donnée des pucerons dans le troisieme volume, et dans celle'des gall'insectes par laquelle commence le 4e volume.*

je ne dois pourtant pas cacher le mal que je scay d'elles. une espece de mediocre grandeur, d'un brun presque noir, et tres luissant maltraita fort sous mes yeux les fleurs d'un abricotier qui avoit fleuri des premiers. quand je remarquai que les fourmis etoient en tres grande quantite sur cet arbre je ne crus pas d'abord que ce fut a mauvaise intention, je crus qu'elles y etoient attirees par des gallinsectes, ou par des pucerons, mais mon jardinnier me fit observer qu'elles en vouloient aux fleurs; elles coupoient le pistile du fruit, et souvent le fruit lui meme lorsqu'il commencoit a se nouer. cette espece et plusieurs autres peutetre peuvent donc faire beaucoup de desordre dans les arbres en fleur sur lesquels elles se rendent. on les accuse aussi de ronger les tendres bourgeons.

si l'on examine les fourmis qui forme le long de la tige d'un arbre des files montantes, et des files descendantes tres fournies, elles paroitront toutes de la meme espece, et il y a apparence qu'elles sont toutes d'une meme societe; il semble que les pucerons, et les gallinsectes qui ont ete decouverts sur un'arbre soient un fonds appartenant a la fourmillere de celles qui en ont fait la decouverte. au moins en es ce un en possesion tranquille du quel restent ordinairement celles

qui s'en sont emparees. d'autres qui ne commenceroient a y s'y rendre qu'une a une seroient trop foibles pour resister a l'espece de corps d'armée qui s'opposeroit aux tentatives faites par ces etrangers pour partager la recolte des liqueurs sucrees fournies par les pucerons, et les gallinsectes.

il n'est pourtant pas sans exemple que des fourmis de differentes especes se soient disputes par des combats la possesion d'un arbre. une bataille, et la plus memorable peutetre de celles qui ont ete donnees en pareille occasion, a ete rapportee et agreablement decrite par Aeneas Silvius[35] *qui fut pape ensuite sous le nom de* [*Pius II*].

*elle a ete racontee d'apres lui par la plupart des historiens des fourmis. elles se passa aux environs de bologne un poirier sec en fournit le champ, apres avoir ete le sujet de la querelle. des fourmis d'une petite espece y trouvoient de quoy vivre, des fourmis plus grosses entreprirent de les en chasser, elles en tuerent quelques uns et en obligerent beaucoup plus a prendre la fuite. ces dernieres rendues a leur fourmillere y informerent leur compagnes de l'injustice et des mauvais traitements qu'on leur faisoit et leur demanderent du secours pour en tirer vangeance. au bout de deux heures une armee partit de la fourmillere, le nombre de ses combatants rendit bientot toute noire la terre des environs du poirier. les petits fourmis monterent courageusement le long de l'arbre ou les grosses fourmis les attendirent avec intrepidite. les premiers chocs furent rudes, les usurpatrices etoient superieures en force, et les autres l'etoient en nombre il y en avoit plus de 20 de celles ci contre une de celles la neantmoins les petites souffrirent beaucoup dans les premieres attaques, il y en eut quantite de massacrees; il se forma au pied de l'arbre un tas des corps morts qui y tomberent, mais enfin les petites fourmis remporterent la victoire, et resterent maitresses du poirier. il peut arriver souvent des combats moins meurtriers entre des fourmis de differentes especes, ou simplement de differentes societes lorsque les unes veulent se conserver a elles seules un arbre ou d'autres voudroient avoir liberte d'aller fourager.**

* *voir les memoires de l'Academie, questions a M Arthur.*[36]

il leur est si commun d'avoir du goust pour ce qui est sucre qu'on ne sera pas surpris qu'y en aiant a cayenne une espece tres grosse et qui se multiplie beaucoup, elle fasse de grands desordres dans les plantations de cannes de sucre a la martinique il y en a de la meme espece, ou d'une espece assez semblable contre lesquelles on a a faire de pareilles plaintes.[37]

il etoit bien essentiel aux abeilles detre armées comme elles le sont, autrement il leur eut ete impossible de conserver le miel qu'elles mettent en provision. mais les fourmis qui se sont etablies meme entre les carreaux de verre, et les volets d'une ruche vitrée n'osent faire de tentatives pour s'introduire dans son interieur tant qu'il est tres peuple de mouches vigoureuses; elles deviennent plus hardies quand elles decouvrent des ruches dont les abeilles sont languissantes, et prestes a perir faute de provision; elles vont leur enlever le peu qui leur en reste. de plus petites recoltes de miel que celles qui sont aux ruches, leur font envie; nous avons vu dans le tome precedent[38] *que beaucoup d'especes d'abeilles solitaires, apportent dans chacune des cellules ou elles doivent pondre un oeuf, la quantite de pastee miellée qui doit suffire a nourrir le ver qui sortira de chaque oeuf, jusqu'a ce qu'il soit en etat de devenir mouche, quand l'une de ces cellules est decouver te par des fourmis avant qu'elle ait ete formée, l'abeille ne scauroit seule defendre le miel qu'elle y a apporte contre la foule des fourmis qui se presente pour le piller. elle n'a d'autre parti a prendre que de le leur abandonner.*

les sucs que des matieres vegetales leurs peuvent fournir ne sont pas les seuls qu'elles aiment; elles sont carnacieres; mais elles ne le sont pas cruellement; quoiqu'armees de deux grandes, et fortes dents on ne les voit pas attaquer meme les insectes qui leur sont tres inferieurs en force, et moins bien caparaconnés. elles se promenent sur des milliers de pucerons incapables de se defendre, sur des milliers de gallinsectes aussi peu en etat de leur resister sans leur faire aucun mal. mais si en leur chemin elles trouvent un cadavre de quelque petit animal elles se mettent a le succer. souvent on leur voit transporter a leur fourmillere de petites mouches; mais elles s'arrestent sur les cadavres trop pesants par rapport a leur force.

qu on prenne garde aux scarabes qui sont morts dans des allees de jardins, et surtout qui ont ete ecrases, aux chenilles, aux sauterelles mortes, et enfin aux cadavres des insectes de presque toutes especes, s'ils ne sont pas trop desseches, s'ils sont encore mols, on verra ordinairement plusieurs fourmis qui sont autour.

ceux aussi qui a fort mauvaise intention contr'elles ont le plus etudie leur goust, aiant remarque qu'elles s'attroupent autour des vers de terre morts ont cru que le meilleur moyen de les detruire dans un jardin, etoit de metre dans un vase plat des verres de terre coupes par morceaux; c'est un appas qui rassemble les fourmis a milliers, et qui donne la facilite d'en faire perir a la fois un grand nombre. du miel n'auroit pas autant d'attrait pour elles qu'en ont ces morceaux de vers. ce secret aureste vient de bonne main, il est imprime dans la traduction françoise du calendrier du jardinier de Mr. Bradeley,[39] *celui a qui nous la devons n'a nullement ambitionne la qualite d'autheur, il na cherche qu'a etre utile, et ne s'est pas soucie qu'on scut qu'il l'etoit.*

aureste quoique les fourmis ne fassent pas une guerre declarée aux insectes, il y a des circonstances ou elles en mettent a mort. si une chenille en continuant son chemin va imprudement passer par une fourmillere, il faut qu'elle soit bien grosse, et bien vigoureuse pour s'en tirer saine et saufve. elle est bientot assaillie de toutes parts par des fourmis dont chacune cherche a lui donner un coup [de] dent. j'ai quelquefois jette a dessein dans une fourmillere des chenilles de mediocre grandeur qui y ont ete tuees sous mes yeux. hors de leur fourmillere on en voit quelquefois d'acharnees sur des insectes vivants, j'en ai vu qui l'etoit sur des pucerons, mais il m'a toujours paru que les insectes a qui elles s'adressoient avoient ete blesses auparavant. ce n'est peutetre pas qu'elles croient avoir plus de droit sur ceux ci que sur les autres, mais les sucs et les chairs qui sortent de la playe irritent leur appetit et d'ailleurs elles voient qu'elles auront moins a batailler. quand je leur ai offert des insectes que j'avoient mis en mauvais etat elles les ont attaques, et ont laisse aller les sains que je mettois a leur portee ailleurs que dans une fourmillere. et peutetre meme ai je avance trop generale-

ment que les fourmis sont carnacieres sans etre cruelles, car une observation m'a paru prouver qu'il y en a au moins une espece qui va a la chasse de certaines petites chenilles. aiant enleve au primptemps un grand vase a fleur sous le pied du quel des fourmis avoient construit avec de la terre une habitation assez considerable je trouvai tout le dessus de celle ci couvert de petites chenilles rares, communes alors; celles de l'espece en question aiment les ormes sur lequelles elles vivent pendant qu'ils sont encore en graine verte.[40] *quoique petites elles sont aisées a trouver, parce qu'elles aiment a se laisser pendre au bout d'un long fil arreste par son autre bout a une branche de l'arbre. il faudroit etre trop favorablement dispose pour les fourmis pour croire que celles dont il s'agit actuellement, n'avoient transporte chez elles que les petites chenilles de l'orme qu'elles avoient rencontrées mortes ou mourantes.*

d'autres chairs que celles des insectes peuvent fort bien leur convenir j'ai souvent donne des morceaux des memes viandes crues que nous mangeons cuites aux fourmis que je tenois renfermées dans des cloches, et elles s'en nourrissoient.

il est connu aussi que pour avoir des squelletes de petits animaux, plus parfaits que ceux que le plus adroit anatomiste pourroit faire; on n'a qu'a metre l'animal mort dans une fourmillere. on peut avoir de la sorte de jolis squelletes de souris, de petits oiseaux de reptiles. les dents des fourmis scavent detacher des portions de chair, de tendons, que le plus fin scapel ne scauroit atteindre quelquefois pourtant ces dents coupent plus qu'on ne voudroit.

elles sont friandes des oeufs d'insectes, qui ne sont couverts que d'une membrane aisée a entamer. plusieurs especes d'Araignées[41] *deposent les leurs les uns aupres des autres sur une feuille d'arbre ou de plante qu'elles ont pliee. la nichée n'est couverte que par une toile de soye blanche sur la quelle paroissent les impressions des bouts des oeufs. l'Araignée se tient aupres de cette nichée, et souvent dessus on croiroit que c'est pour les couver. un autre raison ne leur permet pas de les abandonner; si elle ne veilloit pas continuellement a leur conservation, ils seroient mange par des fourmis. j'en ai eu plus d'une preuve; il m'est arrive plus d'une fois de*

prendre la nichee d'oeufs sans l'oter de dessous sa feuille, de chasser l'araignee; et de jetter ensuite cette feuille par terre ou sur quelque banc dans le jardin. et plus d'une fois il m'est arrive au bout de quelques heures de trouver les fourmis occupées a detacher les oeufs, a les ouvrir, en un mot a les manger. elles n'en laissoient pas un.

j'ai lieu de croire que la terre elle meme peut etre un aliment pour les fourmis qui font des etablissements souterrains.[42] *j'ai mis de ces fourmis dans un poudrier rempli en partie d'une bonne terre ordinaire dans laquelle on ne distinguoit aucuns filaments de racines, et je ne leur ai donne rien autre chose elles ont cependant travaille a remuer la terre, a la miner et elles ont ete souvent dans la nescesite de reparer leurs ouvrages que je prenois plaisir a detruire de temps en temps malgre tant de fatigues, qu'il n'est pas vraisemblable qu'elles aient pu soutenir sans prendre aucune nourriture, plusieurs ont vecu plus d'un an dans la poudrier ou elles ne pouvoient manger ou succer que de la terre.*

les fourmis en general sont si connues que nous avons pu en parler jusqu'ici sans crainte de n'etre pas entendus quoique nous n'aions encore rien dit de leur forme exterieure; il est temps neantmoins que nous venions a faire remarquer ce qui lui est propre, ce que les parties dont elle est composée ont de constant, et les varietes qui se trouvent dans ces memes parties. la tete est moins epaise considerablement qu'elle n'est large et qu'elle n'est longue, sa figure est apeupres triangulaire l'angle anterieur est pourtant abattu, mais en divers temps il ne paroit pas manquer, il est remplace par les bouts des deux dents qui se trouvent appliques l'un contre l'autre. le dessus n'est pas plan, il y est comme divise en deux parties egales selon la longueur, par une cavite peu profonde, chacune de ces parties a quelque rondeur; et c'est assez pres de leur bout que part de chaque cote une antenne composée en filet graine; sur chaque cote aussi mais beaucoup plus pres du bout posterieur que de l'anterieur est place un oeil a rezeau assez gros pour etre apperceu des qu'on le cherche, quoiqu'il n'ait ni le volume ni l'eclat qu'ont ceux des papillons, et de la plupart des mouches. trois autres yeux bien moins sensibles, trois yeux lisses, disposes triangulairement se trouvent entre les

precedents dans la portion creuse. Cardan a pourtant pretendu Aveugles, et Aldrovande sentant la nescesite qu'elles avoient de voir accorde a Cardan qu'il ne convenoit pas qu'elles eussent des yeux sur une si petite teste, mais il est dispose a croire avec Albert Legrand qu'elles en ont au bout de leurs antennes.[43] *la tete est mobile en touts sens au moyen du col qui la joint au corcelet. celui ci est tres long dans le commun des fourmis, souvent plus long que le corps. il est moins epais d'un cote a l'autre que de dessus en dessous; dessus il est comme bossu et a des rugosites. les six jambes y sont attachées. apres la derniere paire il devient tres delie. dans quelques fourmis il finit par une file de deux ou trois noeuds qui semblent autant d'articulation, la aumoins il y en a une et elle y devoit etre pour permettre divers mouvements que les fourmis font faire a leur corps; elles peuvent le ramener en dessous du corcelet vers la tete. quelquefois elles s'en font un siege sur lequel le corcelet est tout droit elles ont alors une attitude assez plaisante, dans laquelle leurs jambes posterieures aident a les retenir pendant qu'elles tiennent en l'air leurs jambes anterieures, lorsqu'alors elles font gesticuler celles ci il semble qu'elles veuillent prescher.*

leur corps n'a que cinq anneaux il auroit assez la figure d'un cone tronque sans l'arrondissement qu'il prend pour se joindre au corcelet il ne lui est uni que par un fil, aussi delie que celui par le quel le corcelet et le corps d'une guespe ichneumon tiennent ensemble.

les fourmis parmi les quelles on en trouve d'aislées en certaines saisons sont aussi de vrayes mouches[44] *de la classe de celles a quatre aisles et eussent du se trouver dans cet ouvrage immediatement apres les ichneumons. si d'autres considerations n'eussent empeche de leur donner la place que les parties qui les caracterisent, demandois qu'on leur donnat dans toutes les especes que j'ai observées les fourmis qui ont des aisles les portent de la meme maniere, toutes les tiennent paralleles au plan de position, et un peu croisees les unes sur les autres. les deux superieures sont les seules qui paroissent; elles cachent les inferieures qu'elles surpassent considerablement en ampleur. les premieres ont au moins une fois plus de surface que les secondes.*

nous avons deja vu une autre genre de mouches celui des pucerons dans chacune des especes des quelle il y a des individus aislés et d'autres non aislés; nous avons vu de meme que dans quelques especes de papillons les femelles sont privées d'aisles pendant que les masles en ont de grandes et belles.

parmi les fourmis les aislées sont elles aussi les masles; il etoit naturel de le penser et Swammerdam la cru.[45] *dans la plupart des fourmilleres on peut voir en certains temps des fourmis aislees fort grosses, en comparaison du commun des non aislées, on y en voit encore alors de plus petites qui ont aussi des aisles, je ne scay par quel hazard il est arrive que celles ci aient echapé aux yeux de l'attentif observateur que nous venons de nommer, mais il n'a pas manqué d'observer quelques fourmis non aislées dont le corps egaloit ou surpassoit en volume celui des plus grosses fourmis aislees. il a pense que les grosses fourmis aislees etoient les masles, qu'elles etoient dans la fourmillere ce que sont les faux bourdons dans les ruches des abeilles; que les grosses fourmis non aislées etoient les femelles; et enfin que toutes les autres fourmis etoient depourvues de sexe, qu'elles etoient chargées de touts les travaux de la fourmillere, comme le commun des mouches a miel l'est de ceux de la ruche et qu'elles pouvoient porter a bon titre le nom d'ouvrieres.*[46] *la dissection la confirme dans l'idée que l'analogie, et le volume du corps lui avoient donnee des grosses fourmis non aislees, elle lui a montre que leur ventre etoit rempli d'oeufs. si meme sans s'embarasser d'ouvrir leur corps on se contente de le presser fortement on fait sortir par l'anus, et souvent par quelqu'endroit ou il s'est crevé, une masse molle et blanche, qui etant examinee a une forte loupe ne paroit etre qu'un amas de grains ronds qu'on ne peut prendre que pour des oeufs.*

mais le jugement qu'a porté Swammerdam des grosses fourmis aislees, en en faisant des masles et cela apparemment parce qu'il ne voioit pas en pouvoir faire autre chose, ce jugement dis je n'est pas aussi vray. si pour examiner leur sexe il eut eu encore recours a la dissection, ou simplement a une forte pression, il eut fait sortir de leur corps des oeufs quelquefois parfaitement [*semblables*] *a ceux*

qu'il avoit tires du corps des grosses fourmis non aislees; mais quelquefois pourtant moins distincts, ou moins gros. en un mot il seroit reste convaincu que les grosses fourmis aislees etoient elles memes des femelles.

y a t'il donc dans une fourmillere deux sortes de femelles des aislées et des non aislees? non il n'y en a qu'une sorte; les unes et les autres sont les memes vues en differents temps. il arrive constamment aux fourmis aislees ce qui n'arrive a aucun autre animal connu de la classe de ceux qui portent des aisles elles perdent les leurs. un oiseau a qui les deux aisles se seroient tombées nous paroitroit dans un etat bien miserable. la fourmi qui en avoit quatre, et qui dans un certain temps s'etoit bien trouvee de les avoir se trouve mieux dans un autre temps de ne les avoir plus. si on compare donc une grosse fourmi sans aisles avec une grosse fourmi aislee on ne trouvera aux aisles pres aucune difference entr'elles quoique Swammerdam ait cru y en appercevoir plusieurs; la plus reelle de celles qu'il cite est une difference de couleur, qui se reduit a une nuance de couleur plus pasle dans l'une que dans l'autre; mais il est ordinaire d'observer de ces sortes de differences dans les memes animaux consideres en differents ages.[47]

les anciens naturalistes au lieu de nous apprendre ce fait singulier de l'histoire des fourmis, qu'il vient un temps ou les aislees perdent leurs aisles, nous en ont unanimement certifie un tout opposé, ils ont assure qu'apres avoir ete depourvues d'aisles dans leur jeunesse et dans leur age de vigueur elles en prennoient dans leur viellesse, que des aisles leur poussoient lorsqu'elles etoient devenues caduques et prestes a mourir. on ne seroit pas assez fonde a nier un fait si generalement avancé, si on n'avoit qu'a y opposer qu'il ne paroit pas vraisemblable que des aisles aient ete accordees aux fourmis simplement pour les faire perir avec plus de dignite ou comme le veut Cardan[48] *comme une consolation dans leur viellesse; qu'elles aient ete accordées a des fourmis qui ne sont plus en etat d'agir pour le bien de leur espece. mais ici ce qui sembloit ne devoir pas etre n'est pas. lorsque nous suiverons les fourmis dans leurs differents etats nous verrons que celles qui naissent sens aisles passent leur*

vie sans en avoir et que celles qui doivent etre aislees ont comme les autres mouches et les papillons des aisles des le momment de leur naissance, c'est adire apres cette transformation qui les fait reconnoitre pour des fourmis.

*apres n'avoir vu dans une fourmillere que des fourmis sans aisles, au bout de quelques temps on y en a vu d'aislees, et c'est de cette observation qu'on a conclu trop vite, que les fourmis qui avoient alors des aisles etoient de celles a qui on n'en avoit pas vu. on n'a pas a craindre de tirer de meme une fausse consequence des observations qui prouvent que les fourmis perdent naturellement leurs aisles, mais avant de rapporter la maniere aussi aisée que simple de les faire, il est bon d'instruire des circonstances qui y sont le plus favorables et pour les connoitre il faut scavoir comment les femelles des fourmis sont fecondees.**

quand donc on observe en certains temps une fourmillere on y trouve de tres grosses fourmis que nous voulons qu'on croye etre de celles qui ont perdu leurs aisles et qui en sont reellement. on y en trouve d'autres aussi grandes, encore aislées les unes et les autres sont les femelles dont le nombre est toujours fort inferieur a celui qu'on y voit des fourmis non aislées d'une mediocre grandeur, qui sont celles sur qui roule le fort du travail.† on y trouve aussi des fourmis non aislées plus petites et enfin des aislees aussi petites que ces dernieres. si les femelles des fourmis ont besoin de masles, car c'est une question qu'on peut faire depuis que nous scavons que les pucerons sont feconds sans accouplement[49]; il est naturel de soupconner que les petites fourmis aislées sont les leurs; la grande disproportion de taille n'est nullement contraire a cette idée. puisque la regle generale veut que parmi les insectes les masles soient plus petits que les femelles. quelque petit meme que soit un masle par rapport a sa femelle nous n'en scaurions etre surpris depuis que nous connoissons ceux des gallinsectes. je suis etonne qu'aucun hazard n'ait offert a Swammerdam ces fourmis aislées de la petite

* *Ob. si dans les demenagements, auxquels on force les fourmis les aislées grosses et petites, et les petites non aislées se chargent des vers et des nymphes. je crois etre sur que non pour les aislées a revoir.*

† *Obs. il faut scavoir s'il n'y a pas des petites fourmis, moins petites que les petites aislées qui ne scauroient etre celles ci, ou si les petits non aisles ne sont pas les petits aisles qui ont perdu leurs aisles.*

taille, je les ai trouvées dans toutes les societes de fourmis, ce n'a ete a la verite que dans certains temps, car il y a d'autres temps ou l'on ne trouve dans les fourmilleres que des fourmis sans aisles.

bien des raisons que je ne detaille pas encore concourroient a prouver que les petites fourmis aislées etoient les masles; mais pour en avoir une preuve incontestable il falloit etre parvenu a surprendre la femelle et le masle joints ensemble. inutilement ai je cherche cent et cent fois a les voir dans cet etat. les fourmilleres que je tenois dans des vases transparentes ne m'ont rien montre de plus sur cette article que celles de la campagne dont je ne pouvois voir l'interieur qu'apres les avoir boulversees. neantmoins il est non seulement tres certain que les petites fourmis aisles sont les masles, mais il l'est encore que leurs accouplements, qui sont reste cachés pendant une longue suite de sciecles sont plus aisés a voir que ceux d'aucun autre insecte qu'il n'est point qu'il se fassent dans des lieux plus eclaires et qu'ils se font souvent sous nos yeux. quoique les anciens aient donne des eloges a la pudeur de ces petits insectes, sur ce qu'ils ont cru que ce n'etoit que dans les tenebres qu'ils se faisoient les caresses qui tendent a la multiplication de leur espece.

peutetre pourtant n'eusse je pas ete instruit par le premier haza[r]d, qui me mit a portee de voir deux fourmis accouplees, si j'eusse moins connu ces petits insectes[60] *etant en route pour le poitou, et me trouvant sur la levée de la loire assez proche de tours dans un des 1ers jours du mois de septembre 1731; je descendis de ma breline, invite a me promener par la beaute du lieu, et par un air tempere que la chaleur qu'il avoit fait pendant le reste du jour, rendoit tres agreable. le soleil ne devoit plus rester sur notre horizon que pendant une heure. dans ma promenade je vis beaucoup de petits tas de grains sabloneux et terreux eleves audessus des trous qui conduisoient des fourmis a leur habitation souterraine. plusieurs de celles ci se tenoient alors en dehors, elles etoient rouges, ou plutot rousses, et d'une grandeur mediocre. je m'arrestai a considerer plusieurs de ces monticules de terre, et je remarquai sur chacun parmi les fourmis non aislées des fourmis aislées de deux grandeur fort differentes, les unes n'avoient pas le corps plus gros que celui*

des fourmis sans aisles, et a en juger a la vue simple une des autres devoit peser plus de deux ou trois de ces dernieres. sur cette belle levee ou je me promenois avec plaisir, paroissoient en l'air dans des endroits peu eloignes les uns des autres de petites nuées de gros moucherons qui voloient tres vite en tournoyant; et qu'on devoit soupconner etre ou des cousins ou des tipules ou des mouches papillonnacées.[51] *souvent la petite nue se tenoit dans l'air a une hauteur ou la main pouvoit atteindre. je me servis d'une des miennes pour prendre de ces mouches, et j'en pris a bien des reprises differentes. toutes celles dont je me rendis maitre ne devoient pas m'etre difficiles a reconnoitre pour ce quelles etoient; c'etoit des fourmis aislees, semblables a celles que je trouvois a chaque pas sur les petits tas de terre. mais une remarque qui etoit aussi essentielle qu'aisée a faire, c'est que je les prenois presque toujours par paire. non seulement j'en trouvois preſque toujours dans ma main une grosse et une petite, le plus souvent je les y trouvois jointes ensemble, et je les y tenois pendant du temps sans qu'elles se separassent. la petite etoit posée sur la grosse, comme dans les accouplements des mouches ordinaires le masle l'est sur la femelle. le derriere de la petite fourmi etoit recourbe pour s'appliquer sur celui de la fourmi femelle; et il y etoit si adherent qu'il falloit avoir recours a la force pour l'en separer. le corps de ce petit masle n'avoit qu'a peine la moitie de la longueur de celui de sa grosse femelle, aussi ne pouvoit il couvrir que la partie posterieure du corps de celle ci. je pressai le corps de quelques unes des grandes fourmis et j'en fis sortir des grappes d'oeufs.*

pour voir des fourmis accouplées il ne s'agisoit donc que de scavoir le lieu ou elles se tiennent pendant qu'elles le sont; depuis [*que*] *j'eus pris en lair des paires de fourmis rouges dont je viens de parler, il m'a ete aise d'avoir dans ma main des fourmis jointes ensemble de presque toutes les especes de ce pays. les beaux jours d'ete et d'automne, ceux surtout ou le soleil brille, ceux ou des mouches de divers genres forment en l'air de petites nuees, sont aussi ceux ou les fourmis aislées prennent l'essor; elles ne sont pourtant pas toujours rassemblées en l'air en espece de tourbillon, il leur est*

plus ordinaire de s'y disperser, mais souvent elles y sont en si grand nombre qu'on en voit de touts cotes audessus de champs tres vastes. pendant meme qu'elles volent et qu'il n'est pas permis de les observer de bien pres on peut les distinguer, au moins lorsqu'elles sont accouplées, de plusieurs mouches qui ne different pas beaucoup par la grandeur, ou par la forme, on a pour cela un signe si certain que jamais il ne m'a trompe. quand on appercoit en l'air une mouche de la grandeur dont des fourmis peuvent etre qui semble avoir une grosseur au derriere; au derriere de la quelles quelque chose semble pendre, on peut être presque certain que ce que l'on jugeoit une seule mouche est une paire de fourmis. si la mouche qui paroit avoir cette espece de pendeloque au derriere passe a portee de la main et qu'on parvienne a la prendre; on verra qu'on en a pris deux a la fois une grosse fourmi aislee et une autre fort petite mais encore aislée, dont le derriere est acroche a celui de la premiere.

c'est donc au milieu des airs que se doivent celebrer les nopces de ces fourmis qui passent la plus grande partie de la vie sous terre, et le reste en marchant terre a terre ou au plus en marchant sur des murs, sur des plantes et sur des arbres. je me suis quelque fois tenu aupres d'une fourmillere dont une partie des habitantes etoient aislees sur les deux ou trois heures apres midi pendant qu'elle etoit echaufée par les rayons du soleil. alors les fourmis aislées des deux differentes tailles sortoient de terre, elles se rendoient sur le toit, pour ainsi dire, de leur habitation, la apres avoir ete bien rechauffées elles faisoient plusieurs tours de differents cotes, sans que j'aie observe que les petites aislées attaquassent les grandes par des agaceries sans que j'y aie vu aucun tendre prelude. d'instant en instant il s'en envoloit quelqu'une soit grosse soit petite; bientot on pouvoit remarquer que l'air des environs s'en remplisoit. bientot on y en pouvoit appercevoir de grosses que en avoient une petite au derriere non seulement donc elles se tiennent en l'air pendant qu'elles sont accouplées, mais c'est en l'air qu'elles s'accouplent. pour l'ordinaire une femelle n'y reste pas seule longtemps j'ai lieu de le juger ainsi sur ce qu'outre la femelle jointe a un masle que j'avois compte y prendre, et que j'y prennois sans qu'ils se separassent l'un

de l'autre, il m'est quelquefois arrive de prendre en meme temps deux ou trois autres masles, qui jaloux du sort du premier auroient apparemment voulu le desbusquer, ou qui attendoient peutetre qu'il laissoit vacante une place qui etoit l'objet de leurs ardeurs.

aureste j'ai toujours vu les fourmis revenir une a une a la fourmillere, comm'elle en etoient parties[52]*; ainsi c'est en l'air que l'accouplement commence, et qu'il continue. c'est alors a la femelle a y soutenir le masle, c'est au contraire en pareil cas le masle des mouches appellees demoiselles qui porte la femelle.*[53] *la nature semble avoir varie les combinaisons de toutes les manieres dont elles peuvent l'etre. la fourmi femelle vole de differents cotes, sans que son masle l'abandonne, elle l'enleve quelquefois a perte de vue. comme il n'est pas possible de suivre longtemps des yeux, meme celles qui volent le plus bas, que d'autres qui viennent les croiser les font perdre de vue, il ne m'a pas ete possible de scavoir pendant combien de temps dure le vol, et l'accouplement. j'en ai vu quelques unes qui se posoient assez pres de la fourmillere avant que de se separer.*

il a donc ete etabli que les aisles seroient nescesaires aux fourmis tant masles que femelles pour s'accoupler et il semble qu'elles ne leur aient ete donnees que pour cette seule fin. au moins est il certain que les femelles ne conservent pas les leurs longtemps apres qu'elles ont ete fecondees; les masles se defont aussi des leurs mais il y a apparence qu'ils les gardent plus longtemps[54]*; elles ne leur sont inutiles que lorsque le temps est venu ou ils parcourroient les airs sans parvenir a y trouver des femelles de leur fourmillere. car selon toute apparence les accouplements ne se font qu'entre des fourmis nées ensemble qu'entre celles d'une meme societe.*[55]

les observations qui m'ont appris que les aisles nescesaires aux autres animaux qui en ont ete pourvus pendant toute leur vie ne le sont aux fourmis que pendant une partie de la leur sont aussi aisées a faire que decisives et il suffira que j'indique quelques unes de celles que j'ai faites pour metre en etat de les repeter ceux qui en auront envie. dans un des derniers jours du mois d'aoust, vers le temps ou le soleil alloit se coucher, ayant remarque en l'air quan-

tite de fourmis d'une des plus grosses especes de ce pays, j'y en pris trois qui passerent a portee de main. deux etoient jointes ensemble, et la troisieme etoit une femelle qui se trouvoit alors sans masles. je les renfermai toutes trois dans une petite boiste. elles etoient bien vigoureuses, et rien ne manquoit a leurs aisles. quand, le lendemain vers les 9 a 10 heures du matin, j'ouvris la boiste pour observer mes fourmis, je vis qu'une des grosses, ou une des deux femelles n'avoit plus d'aisles; mais elle n'avoit rien perdu de ses forces et de sa vivacite. alors elle me parut parfaitement semblable a ces fourmis non aislees qu'on trouve en petit nombre dans la fourmillere, et qui s'y font remarquer par leur grosseur; je crus donc fonde a soupconner que ces dernieres avoient toutes ete aislees. je retrouvai les quatre aisles dans la boiste elles etoient en si bon etat, si entieres qu'il ne m'etoit pas permis de penser qu'elles eussent ete arrachees par les autres fourmis; pour etre reste si saines, il falloit qu'elles fussent tombees naturellement, comme tombe d'un arbre une feuille dont le bout du pedicule s'est deseche parceque le suc nourricier n'y a plus ete porte en quantite suffisante. rien ne manquoit a ces quatre aisles, qui eussent du etre dechirées en divers endroits, si elles eussent ete emportees par des tiraillements repetés. enfin il n'en restoit pas la plus petite portion, attachee au corcelet de la fourmi. on ne pouvoit que difficilement retrouver les cavites ou leurs sommets avoient ete articules.[56]

le soir du meme jour ou je fis l'observation precedente je renfermai une seule et tres grosse fourmi aislee dans un poudrier de verre. je ne l'observai que le lendemain vers midi, elle avoit alors perdu les deux aisles d'un meme cote et lorsque je revins l'observer sur les deux heures, apres midi, je trouvai que les deux aisles de l'autre cote, etoient tombees a leur tour. aureste la fourmi ne paroissoit pas en avoir souffert. elle sembloit se porter aussi bien qu'une fourmi se peut porter. on verra quelquefois les grosses fourmis aislees, ou les femelles perdre leurs aisles plus vite que ne les perdirent les deux qui furent l'objet des observations precedentes. celles de quelques unes sont tombees presque dans le momment ou je venois de les prendre. mais on pourra aussi prendre des fourmis qui tar-

deront beaucoup plus a se defaire des leurs. j'en pris deux sur une fourmillere faite de brins de bois que je mis comme les dernieres dont il vient d'etre parle, dans un poudrier ou elles resterent pendant huit jours entiers avec leurs aisles; je les fis passer ensuite dans un autre poudrier ou etoient des fourmis ouvrieres de leur espece par qui elles furent les bien recues. il y en eut cependant une qui mourut au bout de deux ou trois jours et quelques jours apres je ne pus retrouver l'autre. quoiqu'il en soit voila donc des fourmis qui ont conservé leurs aisles dans le poudrier pendant 12 a 13 jours et peutetre plus longtemps pendant que d'autres s'y sont defaites des leurs apres douze a 13 heures de prison et quelquefois plutot. une raison de cette difference s'offre naturellement et a bien l'air d'etre la vraye. les unes avoient ete prises dans l'air, et meme accouplees, leurs oeufs par consequent devoient etre fecondes.[57] *les autres avoient ete prises sur la fourmillere et peutetre avant qu'elles eussent encore fait aucun usage de leurs aisles; il est probable qu'elles n'avoient pas encore soufert les approches du masle. ce qui sembloit devoir disposer a les regarder comme vierges, c'est que lorsque je les pris les nuances de leur couleur etoient plus faibles, qu'elles ne le furent quelques jours apres que je les eus gardees, leur corps et leur corcelet se rembrunirent dans le poudrier, de la il suit qu'elles etoient nouvellement transformées, lorsqu'elles furent prises.*

de quatre a cinq masles que je mis prisonniers dans un tube de verre avec des femelles qui n'avoient plus d'aisles, deux y perdirent les leurs au bout de deux ou trois jours. un voyage que je fus oblige de faire me mit hors d'etat d'observer le temps ou les autres cesserent d'etre aislés.

dans les indes orientales, et dans nos isles de l'Amerique on n'a pas pu ignorer aussi longtemps que dans nos climats, que les fourmis aislees ne le sont pas pour toute leur vie, on y a de frequentes et trop frequentes occasions de leur voir perdre leurs aisles. dans ces pays extremement chauds se trouvent des fourmis qui comme nos papillons phalenes, et comme des mouches de plusieurs de nos especes, volent pendant la nuit, et se rendent autour des lumieres. le nombre de ces fourmis nocturnes est extremement grand et extreme-

ment incommode en certaines nuits chaudes.[58] *alors pendant qu'on est a table on veut avoit les fenestres ouvertes pour laisser entrer un air frais dont on est fort avide, mais les fourmis entrent aussi et viennent couvrir la nappe et les plats. quand ces fourmis bruleroient leurs aisles aux lumieres, elles n'en soufriroient point, elles sont prestes a les perdre. leurs aisles restent pour l'ordinaire entre les doigts qui les touchent, on voit beaucoup de ces fourmis qui laissent tomber les leur sur la table ou elles se sont posées; apres etre arrivées en volant elles ne s'embarrassent pas de s'en retourner en marchant. c'est ce que Mr Rose apres sont [voyage] a la martinique m'a assure y avoir observe beaucoup plus qu'il ne l'auroit voulu. c'est ce que Mr Cossigny m'a dit avoir vu trop de fois a pondicheri.*

mais il n'y a de comparable a la prodigieuse quantite de fourmis dont Mr de Cossigni[59] *fut environne un soir ou il fut oblige d'attendre a une des portes de cette derniere ville jusqu'a ce qu'on vint la lui ouvrir, il n'y a dis je de comparable a cette quantite de fourmis que les nuees d'ephemeres dans les quelles on se trouve dans ce pays pendant certaines nuits sur les bords de plusieurs de nos rivieres. le flambeau qui l'eclairoit, sembla avoir attire autour de lui toutes les fourmis aislees des environs. bientot celles qui se possoient a terre, ou celles qui y tonboient parceque leurs aisles leurs avoient manque, s'y accumulerent a un tel point qu'on pouvoit les prendre a poignée, et c'est ce que ne manqua pas de faire son domestique indien porteur du flambeau il se fit une espece de sac assez grand d'un des bouts de sa pagne, dans le quel il les mettoit a mesure qu'il les avoit ramassees. Mr de Cossigny le questionna sur ce qu'il pretendoit faire de tant de fourmis, et il lui repondit qu'il en feroit un bon souper. Mr de Cossigny qui n'etoit pas tente de se regaler du meme mets negligea de l'interroger sur la maniere dont il assaisonneroit les fourmis pour en faire un plat friand. mais divers relations nous ont deja appris, que des indiens du malabar les assaisonnent avec du poivre; qu'ils les font cuire; ils en font des provisions qu'ils conservent pendant plusieurs jours. peutetre que ces fourmis n'ont pas l'odeur qui nous deplait dans les notres; peutetre aussi qu'une pareil odeur est par rapport aux indiens ce que*

le fumet d'une perdrix est pour nous. Mr de Maupertuis*[60] *nous a dit que dans la suede on distile une eau de fourmi, dont on jette quelques gouttes dans les verres de biere de ceux qu'on veut regaler. qu'il avoit bu a Upsal de la Biere qui avoit de cette liqueur, et qu'elle ne lui avoit pas paru desagreable.*

si l'on fait attention aux differents travaux auquels les fourmis ouvrieres se doivent livrer, entr'autres a celui de trainer de pesants fardeaux dont elles sont si occupees, et a la disposition des chemins etroits, et souvent raboteux de l'interieur de leur habitation surtout lorsqu'elle est construite de brins de bois, on jugera que des aisles leurs eussent ete souvent inutiles, et meme incommodes, elles les auroient embarrase en mille occasions, et les auroient surcharge dans d'autres. pour des raisons semblables il est avantageux aux femelles qui ont ete fecondees de perdre les aisles qu'il leur importoit d'avoir avant leur fecondation. une fois fecondees elles n'ont plus a parcourrir les airs, elles sont obligees de se tenir dans l'interieur de la fourmillere dabord pour y pondre leurs oeufs, et ensuite pour y donner aux petits qui en eclosent les soins qu'elles leurs doivent. enfin quand les masles n'ont plus de femelles a qui ils puissent faire l'amour ils ont des occupations assez semblables a celles des ouvrieres, il ne leur convenoit donc pas plus alors qu'a celles ci d'avoir des aisles.[61]

quelques deguises que soient les masles qui ont perdu les leurs, et quoiqu'ils se trouvent mesles avec d'autres fourmis presqu'aussi petites qu'eux on peut toujours s'assurer de leur sexe.[62] *on n'a qu'a presser entre deux doigts le corps de la fourmi qu'on a prise et de l'etat de laquelle on est incertain. dans celles de plusieurs especes on fait sortir un paquet de trois corps oblongs appliques les uns contre les autres. la pression augmentee oblige ces corps a se montrer de plus en plus et enfin a secarter les uns des autres. ils sont touts trois des lames ecailleuses, un peu courbés en goutierre vers le ventre les deux des cotes ont leur bord arrondi et borde d'une frange de poils, c'est a son bout que la superieure ou celle de milieu est le plus large elle s'y termine par une espece de croissant entre la*

* *q. a scavoir mieux de M. Camus.*

lame ecailleuse de chaque cote et la lame du milieu ou la superieure, [de là] part un long filet ecailleux qu'on ne decouvre que quand les lames sont assez ecartees les unes des autres. on ne trouve pas de pieces semblables au derriere des fourmis ouvrieres qui n'ont point de sexe,[63] ni au derriere des femelles. c'est aussi avec ces pieces analogues a celles des masles de divers autres insectes que chacun de ceux des fourmis saissit en l'air la partie posterieure de sa femelle, et qu'il s'y tient cramponne pendant qu'elle le transporte de differents côstes.

aureste on trouvera des varietes dans le nombre et la figure des pieces que la pression oblige a se montrer a la partie posterieure des fourmis masles de differentes especes. mais on ne trouvera jamais de ces longues pieces au derriere des ouvrieres, ni a celui des femelles.

quelqu'occupée, et quelque active que soit la vie du dehors parmi les fourmis, celle de l'interieur n'est pas moins laborieuse; quand elles se retirent dans leur habitation, au moins dans les saisons qui ne sont pas trop rigoureuses, ce n'est nullement pour s'y reposer. c'est la que les meres pondent leurs oeufs; les petits qui en eclosent sont le grand objet des soins des ouvrieres, elles sont leurs nourrices, et parmi les insectes, et peutetre parmi les hommes il seroit difficile d'en trouver d'aussi affectionnees a leurs nourrissons, et qui soient obligées de prendre autant de peine pour eux.[64] les oeufs que les meres mettent au jour sont d'une grosseur fort differente de ces corps longs, qui ont quelque ressemblance avec l'amande d'une pomme de pin, auxquels on donne vulgairement le nom d'oeufs de fourmis. quand ils sortent du corps de la mere ils sont si petits que vus avec une loupe de quatre a cinq lignes de foyer, ils ne paroissent pas plus gros que la tete d'une tres petite epingle. malgre la quantite que les meres en pondent on ne peut donc gueres se prometre de les chercher avec succes dans une fourmillere soit de petits batons soit de pure terre, aumoins mes tentatives pour les y trouver ont toujours ete inutiles. j'ai eu recours a un expedient dont j'ai eu plus lieu d'etre satisfait. on voit quelquefois courrir sur terre des fourmis sans aisles, qui se font remarquer par leur grosseur, beaucoup plus considerable que celle des fourmis plus communes de meme couleur,

et de meme espece; comme je scavois que ces grosses fourmis devoient etre des femelles qui avoient perdu leurs aisles, il etoit naturel de penser que le temps ou on les voit ainsi courrir est celui ou elles cherchent a faire un etablisement ou sera elevée la posterite qu'elles se sentent prestes a metre au jour[65]; il y a plusieurs annees que j'en pris trois le premier de juillet en intention de les renfermer dans un lieu ou elles ne pouroient gueres me cacher leurs oeufs si elles en faisoient. ce lieu fut un poudrier de trois pouces de hauteur, sur le fond du quel j'avois mis un lit de terre assez humide pour avoir quelque tenacite, et epais au plus d'un pouce. sur cette terre je ne manquai pas de jetter quelques petits morceaux de sucre des morceaux de fruits et quelques cadavres d'insectes; j'avois envie que mes trois fourmis se trouvassent bien du logement que je leur avois donne et qu'elles y fissent la plus importante de leurs operations. les 1^{res} *tentatives qu'elles firent pour sortir aiant ete rendu inutiles par le couvercle du poudrier, elles parurent avoir bientot pris le parti de s'etablir ou je les voulois; elles se placerent meme au mieux a mon gre. apres avoir penetré sous terre, elles se creuserent une cavite commune qui avoit pres d'un pouce de circonference aupres des parois du verre; son fond etoit celui meme de la bouteille, qui la avoit ete mis a decouvert, la terre formoit audessus une espece de voute et s'en trouvoit distante de cinq a six lignes. je pouvois donc voir dans cette cavite tant au travers d'un portion d'un des cotes du poudrier, qu'au travers d'une portion du fond. je vis les trois meres fourmis s'y tenir constament, si elles sortoient de terre c'etoit pendant la nuit, ou ca ete rarement pendant le jour puisque je ne suis jamais parvenu a les surprendre dehors. elles ne semblerent donc pas se soucier d'aller chercher les mets que je leur avois offerts, mais peutetre que le sucre qui se fondoit penetroit jusques a elles, et qu'elles pouvoient succer une terre qui en etoit imbibée sans sortir de leur cavite. il n'est pas sur d'ailleurs qu'elles n'eussent pas trouve de quoy se nourrir dans la terre meme qui les environnoit, n'eut elle pas ete mouillee de sirops, puisque nous avons vu des fourmis, dont il a ete fait mention cidevant, vivre pendant une annee entierre dans un poudrier ou il n'y avoit que de la terre. aureste elles me parois-*

soient s'y porter bien, elles s'y donnoient divers mouvements dont la fin ne m'etoit pas toujours connue souvent pourtant elles etoient occupées a aggrandir leur logement, a en rendre la voute plus unie.

elles s'etoient tenues pendant plus de trois semaines dans cette cavite sousterraine lorsque je crus y appercevoir des oeufs pour la premiere fois, car ce ne fut que le 21e juillet.[66] *mais je ne fus bien sur que j'y en voiois que le 4e d'aoust aiant un peu secoue le poudrier, et l'aiant penche vers le cote ou la partie du verre qui renfermoit la cavite n'etoit pas couverte de terre, je fis tomber sur cette partie du verre une masse blanche de la grosseur d'un petit poids. cette masse examinee avec une forte loupe ne paroissoit etre qu'un assemblage de petits grains dont chacun malgre l'augmentation de volume que lui donnoit la loupe n'etoit pas plus gros que la tete d'une petite epingle; mais il etoit sensiblement plus long, peutetre une fois, et un peu courbe, un de ses cotes etoit concave. le seul doute qu'on pouvoit avoir c'est si ces petits corps etoient des oeufs ou des vers; mais la suite de mes observations me prouva qu'ils etoient des oeufs.*

l'enveloppe exterieure, la coque de ces oeufs, ainsi que celle de la plupart des oeufs d'insectes est membraneuse, et il leur etoit essentiel qu'elle le fut; comme ceux de quelques mouches a scie[67] *dont nous avons parle ailleurs ils doivent croitre journellement et croissent assez vite. ces memes oeufs que j'avois observes le 21e juillet avec une loupe qui n'avoit gueres plus de 4 a 5 lignes de foyer, je les observai le premier aoust avec une autre dont le foyer etoit de 30 lignes; alors ils me parurent aussi grands autravers de cette derniere, qu'ils m'avoient paru 6 jours auparavant autravers de l'autre. un accroissement si sensible et si considerable me mit en etat de les reconnoitre plus surement pour ce qu'ils etoient, et d'autant plus surement que je vis parmi eux plusieurs vers nouvellement eclos; je pus donc comparer des oeufs encore pleins aux petits insectes qui etoient sortis de quelques autres. l'examen et la comparaison etoient encore devenus plus faciles a faire, parceque cette masse de la grosseur d'un pois dont j'ai parlé ne subsistoit plus; les oeufs et les vers avoient ete detachés, ils etoient simplement poses tres proches les uns des autres, mais ils n'etoient plus entasses et colles*

ensemble. les oeufs encore pleins etoient blancs et tres lisses, on n'y decouvroit aucune incision. aulieu que la suite des anneaux dont etoit compose le corps de chaque ver etoit aisee a distinguer, la tete ou la partie anterieure etoit tres reconnoissable, elle se recourboit en crochet vers le ventre tantot plus et tantot moins; le ver etoit aussi gros mais plus long qu'un oeuf. enfin autravers de la coque de quelques oeufs dont chacun contenoit un ver presqu'a terme je voiois fort nettement la forme du ver qui ne remplisoit pas entierement la cavite ou il etoit loge, la liqueur destinée a le nourrir en occupoit une partie. les fourmis font donc des oeufs qui sont d'abord reunis dans une petite masse. es ce que la mere les pond tous a la fois ou qu'elle les pond en grape, comme plusieurs mouches ephemeres pondent les leurs? ou si aux premiers oeufs qu'elle a fait sortir de son corps elle attache ceux qu'elle met au jour par la suite. c'est ce que mes observations ne m̄'ont point appris.[68] *il y a aumoins grande apparence que le tas d'oeufs dont il s'est agi etoit la ponte d'une seule mere, de la seule des trois qui s'etoit trouvee feconde. dans une autre experience j'ai eu deux masses d'oeufs de deux fourmis que j'avois etablies comme les precedentes dans un poudrier dont le fond etoit couvert de terre et quelquefois j'ai eu plus de ces nichees d'oeufs que de fourmis femelles soit que la meme mere en ait pondu plus d'une, soit qu'une des nichees ait par la suite ete divisee en deux. toutes n'ont pas ete aussi longtemps renfermees dans le poudrier que les premieres sans y faire des oeufs quelques unes en ont pondu au bout de quatre a cinq jours.*

ce qui seroit plus important a eclaircir, c'est comment ces oeufs croisent.[69] *la mere fourmi les nourrit elle pour ainsi dire en les humectant? un point noir que j'ai distingué a l'un de leurs bouts feroit il l'office d'une bouche? ou n'est il pas plus probable, que l'humidite qui penetre la coque porte dans l'interieur du suc nourricier. aumoins est il certain que les meres prennent beaucoup de soin de ces oeufs, qu'elles scavent les places qu'il leurs sont les plus convenables. lorsque j'en avois fait tomber une nichée sur l'endroit ou le poudrier avoit toute sa transparence, pour etre a portee de l'examiner de plus pres, la mere ne l'y laissoit pas longtemps. elle*

la venoit saisir entre ses dents, et la transportoit ailleurs. dans la place meme ou elle la mise elle la soigne, elle la leche, elle la retourne sans dessus dessous et elle ne l'y laisse peutetre jamais une journee entierre. elle scait ou les oeufs jouiront d'une humidite plus convenable elles les y porte enfin elle paroit occupee d'eux du matin au soir.

si les oeufs demandent des soins, les vers qui en eclosent en demandent bien davantage j'en ai vu dans quelques circonstances 10 a 12 encore tres petits qui tenoient ensemble qui composoient un petit paquet l'humidite propre a chacun suffisoit peutetre a les tenir colles ensemble.[70] ils n'ont rien de fort remarquable dans leur forme. communement ils sont blancs, ceux de fourmis de certaines especes sont grisatres, il y a dememe quelques varietes peu considerables entre ceux de differentes fourmis. touts sont depourvus de jambes, et non seulement incapables de marcher mais meme de se trainer; il n'est pas meme en leur pouvoir de changer de place leur corps est compose d'une suite d'anneau leur partie anterieure est plus efilee que la posterieure dans quelques uns celle ci est extremement renflee, par rapport au reste. et est precedee d'un etranglement. la tete est armée de deux dents.*

nous scavons que chaque republique de guespes doit son origine a une seule mere qui sans etre aidée, ni meme accompagnée par aucune autre guespe prepare un lieu ou elle construit les cellules dans les quelles elle depose ses premiers oeufs. cet etablisement qu'elle a commence seule est peuple avant la fin de l'ete de plusieurs milliers de mouches de son espece qui lui doivent le jour. nous scavons aussi que les nouvelles républiques de mouches a miel ont des commencements differents, qu'elles sont des colonnies composees d'un nombre de mouches déjà grand, mais qui dans la suite est considerablement augmente par la fecondite de la seule mere qui se trouve dans la colonnie ou l'essaim. mes observations ne m'ont pas encore mis en etat de decider si les republiques des fourmis comme celles des guespes sont fondees par une seule mere,[71] sans le secours d'aucune ouvriere ou si elles le sont par une ou plusieurs femelles a la suite

* *A Revoir.*

des quelles se sont mises plusieurs ouvrieres pour se charger de tous les travaux. un etablisement qui n'auroit encore qu'une fourmi ne seroit pas aise a decouvrir. a moins qu'il n'eut dejà des n'ymphes on ne le distingueroit pas d'un trou en terre ou une fourmi seroit entree pour quelque raison a nous inconnue. j'ai vu des fourmilleres de l'espece de celles qui ont plusieurs pieds de diametre tant horizontalement que verticalement qui n'etoient pas plus grosses que le poing, et qui alors n'avoient qu'un nombre de fourmis proportionne a leur grosseur, mais rien n'y apprenoit s'il y avoit eu un temps ou une de ces fourmis, une mere avoit ete seule. aureste je suis plus dispose a croire que dans les nouveaux etablisements des fourmis comme dans ceux des abeilles il y a toujours des ouvrieres, et cela sur ce que la meme mere pond une tres grande quantite d'oeufs a la fois ou en peu de temps; or les vers qui en sortent ètant incapables d'aller chercher les aliments qui leurs sont nescesaire, il est de toute nescesite qui leurs soient apportes; et c'est a quoy il ne paroist gueres possible que la mere puisse suffire. ceux qui sont nes dans mes poudriers y ont toujours peri longtemps avant que d'etre parvenus en etat de se metamorphoser, ce que j'attribue en partie a ce que la mere ne pouvoit seule les fournir d'aliments. elle auroit eu besoin d'etre aidee par des fourmis sans sexe.[72]

les vers ont besoin d'avoir un grand nombre de celles ci a leur service et qu'elles soient comm'elles le sont tres actifves. le soin qu'elles ont de leur apporter a temps et heure des aliments convenables n'est que la plus petite partie des bons offices qu'elles doivent leur rendre, elles sont obligees de veiller continuellement sur eux, de les tourner et retourner pour le metre dans les positions les plus commodes, et ne les laisser pas trop longtemps dans la meme. elles cherchent d'ailleurs a les faire jouir de l'air dont la temperature leur convient le mieux soit par le degre de chaud soit par le degre d'humidite ce qui exige qu'elles les portent tantot vers le haut, et tantot vers le bas de la fourmillere. enfin parmi les insectes il n'y en a pas qui demandent a etre aussi soignés que ces vers et qui le soient si bien. quand ils ont pris leur accroissement ils se metamorphosent en nymphes. il en est des differentes especes de ces

vers comme des differentes especes de chenilles, les uns quand ils sont prests de devenir nymphes se renferment dans une coque de soye qu'ils se filent d'une manière qui sera expliquée dans la suite, les autres se métamorphosent sans se faire de coque.[78] *les guespes, et les abeilles sont debarassées des soins qu'elles donnoient a leurs vers des qu'ils se sont renfermes dans leur cellules; elles n'ont plus rien a faire pour eux lorsqu'ils se sont changes en nymphes. les fourmis ouvrieres ne sont pas dans un cas si heureux, leurs fourmis elles n'ont pas a la verite a porter de la nourriture aux nymphes, mais a cela elles ont a prendre pour celles ci toutes les autres peines qu'elles prennent pour les vers.*

les fourmilleres n'ont pas des vers et des nymphes en toute saison, ce n'est que vers la St Jean qu'on en trouve a celles qui sont faites de brins de bois, auxquelles nous allons nous arrester parcequ'il est plus aise de les suivre dans tout le cours de l'annee que les autres, et qu'elles sont les plus peuplees; si on met a decouvert l'interieur de quelqu'une de ces fourmilleres pour y chercher les vers et les nymphes, on est oblige de fouiller plus ou moins avant selon l'heure du jour, et selon que le temps qui l'a precedee, a ete sec ou pluvieux, chaud ou tempere ces vers et ces nymphes sont rassembles les uns aupres des autres dans un meme endroit souvent en tres grand nombre. lorsqu'on est parvenu a en voir, on en voit bientot des tas considerables; mais le lieu qui leur convient lorsqu'il a fait tres sec ne sera plus celui ou elles seroient bien lorsqu'il aura plu. d'ailleurs un certain degre de chaleur leur est favorable, il leur est avantageux de profiter de celle que les rayons du soleil font penetrer dans l'interieur de l'habitation, mais il y a des heures ou ces rayons rotiroient de petits insectes dont les chairs sont molles et tendres, s'ils se trouvoient trop pres du sommet de l'edifice ils seroient mal places a midi ou ils etoient bien a sept ou huit heures du matin. dans differents jours, et dans differentes heures du meme jour, les fourmis ouvrieres sont donc obligées de transporter plus haut ou de descendre plus bas touts les vers et toutes les numphes. si on scavoit moins combien elles sont actives on seroit effraie pour elles*

* *q. scavoir si a midi on les trouve a la profondeur ou ils sont le matin.*

d'un si grand ouvrage quand on scait la prodigieuse quantite de vers et de nymphes a qui elles ont a faire. il y a telle fourmillere qui en a peutetre assez pour remplir un litron.[74] *mais quand on a vu a l'oeuvre ces laborieuses fourmis on admire leur activite, et on n'est plus surpris qu'elles viennent a bout d'executer tres vite ce qui eut paru demander un temps tres long.*

je me suis souvent donne le plaisir de leur voir faire de ces demenagements, et c'etoit un plaisir qu'il m'etoit aise de me donner. dans un assez grand poudrier de verre je jettai pesle mesle des fourmis, des vers, des nymphes et des brins de bois de leur fourmillere; il en fut presque rempli; et bien bouché ensuite. les fourmis ne tarderent pas a travailler a metre tout en ordre, les brins de bois furent touts remues un a un et disposes de maniere a laisser des chemins libres. les vers et les nymphes dont il y avoit plusieurs centaines, et peutetre des milliers furent portes sur le fond du poudrier du cote qui etoit le plus dans l'obscurite. quand je tournois par la suite ce meme cote vers le grand jour, vers la fenestre dans l'instant je faisois faire un demenagement; les nymphes et les vers etoient transportes vers le cote oppose et le transport en etoit fini souvent en moins d'un cart d'heure.*[75]

mais pour voir avec quelle diligence elles scavent les porter d'un lieu a un autre il ne faut que s'arreter a considerer ce qui se passe dans une fourmillere ou l'on vient de metre a decouvert un depost qui leur est si cher. quelqu'etendue et quelqu'epaisse que fut la couche des vers et des nymphes, a peine en reste t'il quelques unes de celles ci, et quelques uns de ceux la au bout de moins d'un cart d'heure. chaque fourmi vient prendre entre ses dents un de ces petits insectes incapables de se mouvoir, elle l'eloigne d'un lieu ou il paroit ne pouvoir etre en surete, elle va le loger a quelque distance de la fourmillere sous une pierre, sous un motte de terre, sous des feuilles ou elle le croit hors de risque. aussitot elle retourne a la fourmillere en prendre un autre. chacune scait tenir entre ses dents le vers le plus tendre, la nymphe la plus molle sans lui faire aucun mal. on ne scauroit assez admirer avec combien d'adresse elles les menagent.

* *exp. essentielle si des fourmis soigneront les vers d'une autre fourmillere.*

quand l'orage est passe; quand le curieux qui avoit boulverse la fourmillere la laissee tranquille, elles se remettent a travailler a la retablir dans son premier etat. elles se souviennent des lieux ou elles ont laisse de faibles animaux pour qui elles ont tant d'affection, elles les reportent a la fourmillere et les y entassent les uns sur les autres.

quelquefois elles ne les retrouvent pas ou elles croioient les avoir places le plus surement. les hommes tirent parti de tout. ceux qui elevent des perdreaux, et des faisandeaux[76] *scavent tres bien que la meilleure nourriture qu'on puisse donner a ces oiseaux nouvellement eclos, est ce qu'on appelle vulgairement des oeufs de fourmis, c'est a dire les vers et les nymphes de ces insectes; ils ont vu que les fourmis ne leur donnoient pas le temps d'en enlever autant qu'ils en voudroient, qu'elles etoient plus diligentes a les emporter au loin qu'ils ne l'etoient a les ramasser.* nous ne devons etre bien surs d'etre superieurs en ruses aux fourmis. voici comm'on les trompe. on met plusieurs feuilles de chou aupres d'une grosse fourmillere qu'on a renverse ensuite sans dessus dessous avec un baton, ou une beche, et dans laquelle on entretient le trouble avec le meme instrument. les fourmis qui cherchent a sauver leurs vers et leurs nymphes ne croient les pouvoir mieux loger et plus surement que sous les feuilles de chou. elles les y rassemblent, et les entassent, sans se douter qu'elles donnent au raviseur qui les veut enlever la commodite de les prendre a poignées, la ces insectes delicats ne sont point mesles avec des brins de bois desquels on ait besoin de les separer comme dans la fourmillere. ils y sont pour ainsi dire êpeluches.*[77]

les fourmis qui batissent sur terre et avec de la terre, mais en plein air, celles qui cachent sous de[s] vases ou sous d'autres corps les fourmilleres qu'elles elevent avec de la terre, celles qui se tiennent sous terre, et enfin celles qui batissent avec de la sciure de bois dans des creux d'arbre ou ailleurs ont pour leurs petits la meme affection que celles dont nous venons de parler. Swammerdam en a observe des premieres logees dans une motte de terre, qui dans le cours de la journee faisoient faire a leurs vers et a leurs nymphes tout le tour

* *exp. a faire.*

de la motte pour les faire jouir pendant tout le jour des rayons du soleil.[78] *j'ai vu de celles qui s'etablisent sous les vases, tirer leurs petits hors de la fourmillere, a certains heures, et les faire rentrer dedans, a d'autres heures et j'ai vu pratiquer de ces tendres maneges tant aux fourmis qui se tiennent sous terre qu'a celles qui batissent dans des lieux plus secs avec la sciure de bois.*

il n'est point de fourmis a qui j'aie fait faire plus de demenagements et de plus complets et que j'aie pu examiner de plus pres pendant qu'elles demenageoint qu'a celles qui pour profiter de la chaleur qui regne dans les ruches vitrees, se sont souvent logees entre le volet d'une de mes ruches, et de ses carreaux de verre. toutes les fois que j'ouvrois le volet sous le quel elles etoient, je mettois au grand jour touts leurs vers et toutes leurs nymphes; pleines d'inquietudes pour les uns et pour les autres, elles travailloient sur le champ a les transporter ailleurs. moins pour les aider, que pour voir si elles ne renonceroient pas a un lieu par lui meme si convenable, mais ou elles etoient trop en risque d'etre inquiettees, je balayois et fourmis et petits, je rendois la place nette. souvent dans la meme journée et au plus tard le lendemain je trouvois l'entre deux du volet et du carreau de verre aussi peuplé de fourmis, et aussi fourni de vers et de nymphes qu'il l'avoit ete la veille.

j'ai parle ci devant de petites fourmis rouges a qui l'interieur d'une tete de chardon a bonnetier avoit donne un logement assez spacieux pour elles et pour leurs nymphes et que Mr Bonnet avoit tenues du temps dans son cabinet.[79] *un jour il crut leur faire plaisir en mettant au soleil la tete de chardon, mais des qu'elle eut [été] echaufee les fourmis en partirent en foule emportant leurs nymphes qu'elles allerent cacher dans la terre du vase, dans laquelle la tige du chardon etoit piquee. la chaleur que Mr Bonnet avoit cru leur devoir etre agreable eut ete funeste aumoins aux nymphes, si les fourmis n'eussent pas scu les derober a son action en les enfoncant en terre.*

quoique je me sois mis a portee d'observer d'aussi pres qu'il est possible les fourmis qui avoient des vers a soigner je n'ai pu m'assurer du nombre de fois qu'elles portent chaque jour la becquée a

chacun. cette becquée ne m'a jamais paru etre autre chose qu'une goutte de liqueur que la nourrice fait sortir de sa bouche et qu'elle presente a celle du ver qui ne manque pas de la succer parcequ'elle n'est apparemment presentee qu'a celui qui en a besoin.*[80] *je n'ai jamais vu d'ouvrieres qui portassent aux vers des aliments solides tels que pourroient etre des portions de fruits, des intestins d'insectes, etc. quand elles ne leur donnent pas a manger elles les lechent, elles semblent les caresser, ou plutot elles leurs rendent des services dont nous ne connoissons pas assez l'utilite. les femelles entrent aussi en partage de touts ces soins, puisque comme je l'ai deja dit, celles que j'ai tenues dans des poudriers, sans qu'elles y eussent des ouvrieres a leur service, ont pris soin des vers auxquels elles avoient donne naissance.*

le temps precis qu'il faut pour l'accroissement complet de chaque ver, dans les saisons favorables m'est inconnu mais il y a apparence qu'ils ne l'acquierrent qu'apres plusieurs changements de peaux. des depouilles de differentes grandeurs qu'on trouve en certain temps en tres grand nombre me le font juger. plusieurs raisons longues a deduire, me font croire aussi qu'au bout de 14 jour de vie ou environ, le ver est en etat de se transformer.[81] *les uns comme je l'ai dit se changent en nymphes, qui n'ont pas besoin de se trouver cachées sous une enveloppe. les nymphes des fourmis de beaucoup d'autres especes ne seroient pas a leur aise si elles n'etoient renfermées dans une coque de soye. aussi les vers sous la forme des quels ils ont cru, scavent filer comme le scavent tant d'especes de chenilles.*

dans la vue de pouvoir observer de ces vers pendant qu'ils se construisoient leur coque,[82] *j'en mis dans un poudrier un grand nombre de ceux d'une fourmillere construite de brins de bois qui me parurent pres d'etre a terme, je mis aussi avec eux des fourmis de cette fourmillere, et des brins de bois dont elle etoit composée. des le lendemain je vis dans le poudrier plusieurs coques entierement finies chaque ver peut dans 29 heures ou environ, achever la sienne. mais j'observai ce meme jour et les suivants d'autres vers dont chacun etoit occupe a s'en filer une. jusqu'au moment ou un ver*

* *ob. goutter la liqueur qui sort de la bouche d'une fourmi.*

commence a y travailler, il n'a pas ete en etat de changer de place, il n'a pu, ou n'a pas voulu se donner les plus legers mouvements, il n'a presque fait que ceux des levres et des autres parties de la bouche, dont il ne pouvoit se dispenser pour prendre et avaler la nourriture qui lui etoit offerte, jusque la en un mot il etoit reste presque constament dans la meme attitude, des qu'il sent la nescesite de se faire un logement il devient aussi actif que l'est toute chenille dans le temps qu'elle se construit une coque; il allonge quelquefois la partie anterieure de son corps au point de la rendre efilee, il la racourcit ensuite il la courbe a droit a gauche, il porte sa tete en haut ou en bas. ces differents mouvements tendent a placer et a coller le fil qui sort d'une filiere scituee, comme celle des chenilles a la levre posterieure. il est si prodigieusement fin qu'on ne doit pas se prometre de le voir au travers des parois les plus transparentes d'un poudrier, 'a peine l'apperceveroit on avec une forte loupe en tenant a la main et tres pres des yeux le ver dans la filiere duquel il est engage par un bout. aussi l'etoffe qui est faite de plusieurs couches de ce fil collees les unes contre les autres est si serres qu'on la prendroit pour une membrane, si on ne scavoit pas comment elle a ete travaillée.

les premiers tours de fil, ceux qui sont emploies a faire le batis de la coque, ont besoin d'avoir des appuis, leur assemblage ne scauroit etre entierrement en l'air.[83] *quelques uns sont colles contre des corps solides. quand la coque est finie elle est donc attachée contre ces memes corps qui souvent sont des brins de bois, j'en ai vu qui l'etoient contre les parois du poudrier. mais nous l'avons deja dit il n'en est pas de l'insecte loge dans cette coque, comme de la crisalide d'une chenille renfermee dans la sienne. la crisalide se trouve bien ou la coque a ete filee et notre ver courroit risque de ne pas parvenir a etre fourmi si la coque dans la quelle il doit etre renferme jusqu'a sa derniere transformation restoit dans la place ou il la construite. les fourmis ouvrieres, ou nourrices, qui ne negligent rien de ce qui peut contribuer a la conservation du petit animal qui dans quelques jours pourra les aider dans leurs travaux, detachent sa coque des qu'elle est finie des corps aux quels elle etoit adherante.*

elles la portent dans le lieu ou est le depost precieux qui doit perpetuer leur republique, et la rendre plus florisante; ils la portent dans le lieu ou elles tiennent les vers de tout age, et les autres coques s'il y en a deja eu de filees, elles sont toujours prestes a l'en oter avec tout le reste, des que ce lieu cessera de lui etre convenable, ou qu'elles jugeront qu'un autre lieu convient mieux.

le ver ne reste pas longtemps dans la coque qu'il s'est construite sans se metamorphoser je crois qu'il s'y tient un jour ou deux sans se defaire d'une depouille, qui cachoit les parties exterieures propres a la fourmi. elles paroissent toutes quand cette depouille a ete rejettee; les jambes sont couchées sur le ventre comm'elles le sont dans beaucoup d'autres nymphes; les antennes sont ramenees sur les premieres jambes les aisles, si le ver devoit donner une fourmi aislee, sont tres reconnoissable et sont aussi en grande partie du cote du ventre. la nouvelle nymphe est extrememeht blanche mais par la suite son blanc se salit, elle prend des teintes de brun clair et rougeatre. les yeux a rezeau prennent plutot que tout le reste une couleur assez foncee, et tenant du rougeatre. on les appercoit l'un et l'autre autravers de la coque, lorsqu'on remarque sur un des bouts de celle ci deux points noirs qu'on croit lui appartenir, et qui ne sont autre chose que les deux yeux a rezeau de la nymphe. enfin au bout d'un nombre de jours que je ne scay pas precisement mais assez courts, l'insecte est en etat de quitter une enveloppe tres mince qui tenoit toutes ses parties exterieures emmaillotees, elle la quitte et devient une fourmi dont les dents commencent par s'exercer sur la coque, elles lui font une ouverture par laquelle la jeune fourmi ne tarde pas a sortir.[84] *si celle ci est une de celles qui doivent etre aislées, elle a alors ses aisles a qui il ne reste plus qu'a se developper parfaitement, et ce qui est bientot fait.*

lorsque le temps est venu ou des fourmis ont commencé a sortir de leur coque, chaque jour en vaut un grand nombre de nouvelles, la fourmillere elle devient de plus en plus peuplée, car le nombre de celles qui perissent de mort naturelle, ou par des accidents est beaucoup plus que remplacé. on travaille alors a aggrandir le domicile commun, on en porte plus loin la circonference, et si il est fait de

brins de bois on leleve. mais apparemment qu'il en est des fourmilleres comme de nos villes, qu'il y a un terme par de la lequel il ne convient pas de les aggrandir. quand une fourmillere est devenue tres peuplée et de fourmis de touts sexes, il est vraisemblable qu'il y arrive ce qui arrive en cas pareil dans une ruche de mouches a miel, qu'il en sort un essaim, ou meme plusieurs et que les nouvelles fourmilleres qu on voit paroitre chaque annee a la campagne sont dues a ces essaims.

ce n'est encore qu'au moyen de ces essaims qu'on peut bien expliquer une expedition singuliere que font chaque annee les fourmis dans nos isles de lamerique.[85] *elle est racontee si uniformement par des temoins ocularies qu'il n'est pas permis de la revoquer en doute. le pere du Tertre, et le pere Labat qui a la verite dans ce qu'il nous a donne de mieux et de plus sur n'est que le copiste de celui ci, nous rapportent des fourmis de la martinique, ce que Melle Merian*[86] *nous dit de celles de surinam; pendant deux ou trois jours consecutifs des troupes de ces insectes se presentent pour entrer dans les maisons, elles y arrivent en files si larges, si fournies, et si continues et si longues, qu'inutilement tenteroit on de s'opposer a leur passage; comme l'experience a d'ailleurs appris que loin de venir pour faire du desordre, elles ne s'y rendent qu'avec de bonnes intentions, le pere Labbat assure quon leur ouvre volontiers toutes les portes. elles parcourent les unes apres les autres toutes les pieces de la maison ou elles sont entrees, depuis la cave jusqu'au grenier. elles vont dans tous les coins et recoins de chaque piece. on est oblige de leur abandonner celle ou elles veulent etre, les maitres s'en retirent. en chemin elles tuent touts les insectes qu'elles rencontrent, elles en netoyent la maison. mais ce qu'elles font en cela de plus utile c'est de massacrer les kakerlaques ou ravets.*[87] *elles rendroient un important service aux habitants de chaque maison si elles les delivroient entierrement de cette espece d'insectes de laquelle on a beaucoup a se plaindre. quand ces fourmis ont bien parcourru la maison d'un bout a l'autre elles la quittent pour aller dans la maison voisine. on les a nommées des fourmis de visite, et elles en meritent le nom, elles ne sont pas incommodes par*

la frequence de celles qu'elles rendent, elles n'en rendent qu'une chaqu'annee.

ce n'est assurement ni par politesse, ni par esprit de curiosite que ces fourmis se rendent dans les maisons, il n'y a pas apparence non plus que ce soit pour y faire une grande chasse, qu'elles scavent n'y pouvoir faire assez considerable qu'une seule fois dans l'annee. ce que jimagine de plus vraisemblable sur la cause d'une pareille visite c'est que les fourmilleres des isles de l'amerique, donnent touts les ans dans la meme saison des essaims; que chaqu'essaim avant que de s'etablir a demeure est bien aise de parcourrir et d'examiner une certaine etendue de terrain, pour etre en etat de choisir l'endroit ou il lui convient de se fixer; entrent alors dans les maisons qui se trouvent sur leur route, quand elles y sont une fois entrées elles peuvent etre invitees a les visiter du haut en bas par la quantite du gibier qui s'ofre a elles.[88]

Melle Merian qui a dessiné de ces fourmis nous en a donne des figures gravées dans la pl. 18 des insectes de surinam; qui apparemment representent plus exactement leur grandeur que leur figure, celles aumoins qui sont sans aisles ont a leur corcelet trois renflements, un a l'endroit ou chaque paire de jambes est attachée, que n'ont point les corcelets de nos fourmis d'europe ni aucun de ceux des fourmis qui m'ont ete envoyées de nos isles de l'amerique.[89] *quoiqu'il en soit de la figure de ces fourmis elles sont plus grandes que nos plus grandes d'europe. elles s'etablisent sous terre, et pour n'employer que les termes du traducteur, elles y font des caves qui ont quelquefois plus de huit pieds de hauteur, et qu'elles faconnent aussi bien que les hommes pourroient faire. elles ont comme des fourmis que j'ai recues de Cayenne, qui peuvent etre de la meme espece, de fort longues dents, aussi propres a couper les feuilles des arbres que le peuvent etre des ciseaux; c'est a cette usage qu'elles s'en servent souvent. et elles y travaillent pendant la nuit, du moins doit on le conclure de ce que Melle Merian nous apprend que dans une nuit elles depouillent tellement certains arbres de leurs feuilles, qu'ils sont tels alors que les notres en hiver; qu'ils ne semblent etre que des balays. elle ajoute qu'a mesure qu'elles les*

coupent elles les laissent tomber a terre, et que des milli s d'autres fourmis qui les attendent se jettant dessus, et s'en chargent pour les porter a leur fourmillere et en nourrir leurs vers.[90] *je voudrois scavoir si tout ce que Melle Merian nous rapporte sur cela elle l'a observe elle meme, ou si elle ne le scavoit que sur des rapports d'autrui. je souhaiterois fort encore qu'elle nous eut dit qu'elle a vu elle meme ce qu'elle raconte de la maniere dont elles construisent un pont pour passer en des endroits ou elles ne scauroient arriver autrement dont toutes les parties sont animees; le pont meme qui donne passage a des fourmis est fait de fourmis vivantes. ce sera encore dans les propres termes du traducteur francois que je rapporterai un fait qui meriteroit d'etre bien vu. la premiere s'attache a un morceau de bois qu'elle tient serré avec ses dents, une seconde se place apres la premiere a la quelle elle s'attache, une 3e s'attache de meme a la seconde, une 4e a la 5e et ainsi de suite. et de cette maniere elles se laissent emporter au vent jusque a ce que la derniere attachée se trouve de l'autre cote, et aussitot un millier d'autres fourmis passent sur celles ci qui leur servent de pont.*[91]

quand ces societes des fourmis de tant d'especes que nous avons comparees a celles des tartares parcequ'elles sont toujours prestes a quitter les habitations qu'elles se sont faites des qu'elles cessent d'avoir pour elles les commodites qu'elles y avoient trouvées dabord, quand di[s] je ces societes de fourmis donneroient des essaims, il seroit difficile de s'assurer quelles en donnent. car on peut voir que des fourmis sont venues, ou viennent s'etablir dans un lieu ou il n'y en avoit pas, mais on reste incertain si celles qu'on voit se sont separees d'une societe plus nombreuse; ou si une societe entiere qui a eu en gre de changer de lieu n'etoit composee que de celles qui font le nouvel etablissement. les fourmis qui se font des habitations fixes, comme celles qui construisent les leurs de brins de bois accumules, peuvent donner plus de facilite a resoudre cette question. mais il faudroit qu'un observateur attentif eut dans son jardin, une de ces grosses fourmilleres qu'on ne trouve que dans la campagne. comm'il la pourroit examiner pendant toute l'annee, et a toutes les heures du jour, s'il en sortoit une nombreuse colonnie, peutetre que

le moment ou elle se metroit en marche ne lui echaperoit pas, on pourroit parvenir a voir sortir un essaim d'une fourmillere comm'on parvient a en voir sortir un d'une ruche a miel. le moment de la sortie de l'essaim eut il meme echape a l'observateur, il seroit en etat de juger que la fourmillere en a donne un s'il la trouvoit l'apres midi sensiblement moins peuplee qu'elle ne l'etoit le matin. mais quelque chose que j'ai tente pour etablir une de ces fourmilleres dans mon [[jardin]], quoique j'aie pris plus de peine pour y reussir que d'autres n'en auroient pris pour la detruire, s'ils l'eussent eu dans le leur, je n'ai pu y reussir. ca ete inutilement que j'ai transporte plusieurs fois dans de tres grands poudriers la plus grande partie des habitants de quelque grosse fourmillere. ces fourmis qui pendant quelques jours ont paru se fixer ou je les voulois, ont meprise ensuite toutes les commodites et les douceurs que je leur fournissois soit pour se batir soit pour vivre, non seulement elles ont abandonne leur etablissement, elles n'ont jamais voulu en faire un autre dans mon jardin, elles ont apparemment gagne la campagne, ou elles scavent encore mieux trouver ce qu'il leur faut, quelles ne le trouvoient dans mon jardin malgre touts mes soins.

peutetre que le hazard, auquel nous sommes condamnes a devoir les plus curieuses observations m'a pourtant fait voir une partie de ce qui se passe dans la sortie d'un essaim de fourmis. dans le mois de juillet et un jour ou le soleil etoit ardent pendant que je me promenois en plein midi, dans une allee de charmille, je remarquai sur le gazon qui en occupoit le milieu, des files de ces grosses fourmis qui batissent avec des brins de bois; j'observai bientot que parmi ces fourmis on n'en voiois point qui allassent de deux cotes directement opposes comm'on en voit dans les chemins qui aboutissent aux fourmilleres car celles qui vont a la campagne pour y faire des recoltes prennent la meme route que celles qui retournent porter chez elles le fruit de leurs courses. non seulement je remarquai qu'elles alloient toutes du meme [côté] je remarquai encore qu'elles etoient chargées pour la plupart; les unes letoient d'un brin de bois qu'elles trainoient avec peine, d'autres ne transportoient que quelque graine, ou que quelque enveloppe de graine, mais plusieurs avoient une charge plus

precieuse chacune de celles ci portoit entre ses dents une coque ou une nymphe etoit renfermee ou un ver; ces fourmis en un mot sembloient transporter tout ce qu'il falloit pour etablir une fourmillere, et la metre en etat de se perpetuer; elles seules etoient capables de la bien peupler car je suivis tantot une seule, et souvent plusieurs files de fourmis qui se reunissoient a la plus grosse dans une longueur de plus de 130 a 150 toises.[92] *c'etoit surement la un demenagement, mais comm'il n'est pas ordinaire aux fourmis de l'espece dont il s'agit de dem[en]anger, il est probable que ce demenagement etoit celui d'un essaim, qui s'etoit separe des fourmis avec lesquelles il avoit vecu jusqu'alors.*[93] *si c'en etoit une les colonnies qui sortent des fourmilleres sont mieux traittees, que celles qui sortent des ruches des mouches a miel, ces dernieres n'emportent avec elles que leur industrie, elles n'entrent en partage de rien de ce qui etoit du en partie a leurs travaux, elles laissent aux mouches dont elles se separent toute leur cire, et tout le miel de la ruche; aulieu que les fourmis semblent emporter tout ce qu'elles peuvent de l'habitation qu'elles quittent*[94]*; avant que de se separer de celles qui y doivent rester, elles prennent leur part des meilleurs effets, puisqu'elles en emportent des nymphes qui seront bientot en etat de travailler pour le bien de la nouvelle societe. je ne pus decouvrir d'ou toutes ces fourmis etoient parties, elles venoient apparremment de bien plus loin que les 130 toises le long desquelles il me fut permis de les suivre. je ne pus voir non plus le lieu ou elles se devoient fixer; le choix n'en avoit pas encore ete fait. elles etoient encore dans un etat semblable a celui d'un essaim dont les mouches s'y tiennent disposées en l'air, par cequ'elles ne se sont pas encore determinées pour l'arbre sur lequel il leur convient de se rassembler. j'en trouvois au plus dans quelques endroits sous des feuilles, des vingtaines ensemble, qui y prennoient quelque repos, en attendant que le lieu de reunion eut ete determiné par le grand nombre, ou par celles qui en avoient le droit, car peutetre appartient il aux femelles.*[95]

les fourmis de cette espece ne se doivent pas determiner legerement pour la place ou elles etablisent leur fourmillere; quand elles ont tant fait que d'en construire une quelque part, elles l'affectionnent

*tellement que les accidents les plus facheux ne peuvent les determiner a la quitter. lorsque des curieux qui passent aupres se divertisent a abbatre la petite montagne qu'elles ont elevée, a epa[r]pirler les corps legers de l'assemblage des quels elle est formée, et qu'ils l'ont applanie res terre; les fourmis ne sont pas plutot tranquilles qu'elles songent a reparer de si grands desordres; elles y travaillent avec tant d'ardeur que souvent au bout de peu de jours la fourmillere est tout aussi elevée qu'elle l'avoit ete si alors on abbat l'edifice une seconde fois, elles se remettent a travailler a le retablir. enfin quelque nombre de fois, et quelque frequement qu'on leur joue de si mauvais tours elles ne se rebutent point. il semble que la plus grande peine pour elles est de quitter un lieu qui est extremement a leur gre. on en a vu qui se sont obstinees a rester quoiqu'on eut innonde leur fourmillere a force de jetter dessus des sceaux d'eau, et qui ont tenu contre un traittement d'un genre tout oppose et plus cruel contre celui de faire bruler de la paille sur leur habitation, qui elle meme bruloit en partie.**

s'il est rare qu'on les brule ou qu'on les innonde il est au moins tres ordinaire de renverser leur habitation sans dessus dessous et cela sans autre mauvaise intention que celle de se donner le plaisir de voir avec combien d'activite elles travaillent a reparer les desordres qu'on vient de faire chez elles. dans les premiers moments les yeux ont peine a soutenir les impressions que fait sur eux l'ensemble d'un nombre prodigieux de petits corps animes tres proches les uns des autres qui touts se meuvent avec beaucoup de vitesse, et dans touts les sens possibles. dans les moments suivants, quand le premier trouble est un peu calmé, quand elles ont commencé a se disperser un peu, on n'a qu'a porter les regards succesivement sur differents endroits soit de la fourmillere mise a decouvert, soit de ses ruines pour avoir des spectacles tres varies qui montrent les differentes manieres dont ces petits insectes scavent faire usage soit de leur adresse soit de leur force. les unes tiennent entre leurs dents avec beaucoup de dexterite une nymphe renfermee dans sa coque, comm'un chien instruit a rapporter, tient entre les siens le baton qu'on lui a

* *exp.*

jette avec cette difference que la coque que la fourmi porte est plus grosse qu'elle ne l'est elle meme. le plus grand nombre s'occupe a remetre en place peu a peu les materiaux nescessaires pour couvrir la fourmillere. la fourmi qui a trouve un brin d'herbe, ou de bois menu, et leger le tient quelquefois par un bout entre ses dents droit comm'un cierge, et marche ainsi gaillardement. un autre qui tient encore par le bout un brin de bois plus pesant, le porte devant elle apeupres dans une position horizontale. un brin de bois plus pesant ne peut qu'etre trainé par une autre sous le ventre de la quelle il est quelquefois passe. mais d'autres qui ont entrepris de voiturer une piece de bois considerable par rapport au volume et au poids de leur propre corps pour la tirer avec plus de force vont a reculons, elles se cramponnent sur les jambes de derriere pour la faire venir a elles. on en voit tel autre qui s'occupe a degager le brin de bois qui lui a paru convenable a l'endroit ou elle le veut placer de dessous ceux qui le couvrent en partie. d'autres reunissent leurs forces et travaillent de concert a pousser en avant une piece extremement pesante. c'est en continuant de pareils travaux quelles viennent a bout en quelques jours de retablir la fourmillere dans son premier etat.

dans des temps de trouble, dans des temps de demenagement et meme dans des temps plus tranquilles, on peut souvent voir un[*e*] *fourmi chargee d'un fardeau plus singulier que ne l'est un brin de bois, un grain de terre une petite pierre, et meme que ne l'est une nymphe ou un ver. une fourmi en porte un autre.*[96] *mais si on ne scavoit ce fait on pourroit l'avoir sous les yeux bien des fois avant que de le voir. la fourmi qui se trouve chargee d'une de ses compagnes n'en marche pas moins legerement, et soit qu'elle marche soit qu'elle reste en repos on lui remarque seulement une grosseur en devant de la tete, on juge qu'elle tient entre ses dents une graine ou quelque autre corps d'une figure arrondie. ce qui vient de la maniere remarquable dont la fourmi portee est disposee par rapport a celle qui la porte. une des dents de la premiere est passee entre les deux de la seconde; et reciproquement une des dents de celle ci est passee entre les deux dents de l'autre. la porteuse serre avec les dents celle de la portee qui est entrelles, et dememe la portee serre avec les dents une de celles*

de la porteuse. la portee tient donc bien par ses dents, et est bien tenue par celles de l'autre, et ce n'est qu'ainsi qu'elle tient et qu'elle est tenue, car elle ne fait aucun usage de ses jambes pour se cramponer sur l'autre quoiqu'elles pussent y servir, mais elles y seroient inutiles la grande force des fourmis etant dans leurs dents. la portee a alors ses jambes raccourcies, et appliquees soit contre son ventre, soit contre son corcelet; elle tient aussi alors son corps ramene en dessous vers le corcelet de sorte qu'elle ne paroit qu'un petit paquet brun. elle reste constamment dans cette attitude pendant tout le temps que l'autre la porte, et ce temps est quelquefois long. j'ai vu quelquefois la porteuse faire avec sa charge animee cent et tours devant moy apres quoy je la perdrois soit parcequ'elle alloit au loin soit parcequ'elle rentroit dans la fourmillere.

celle qui se fait porter est pour l'ordinaire sensiblement plus petite que celle qui la porte. j'ai vu souvent la premiere obliger l'autre a se charger delle soit par des caresses, soit par des duretes, car j'ai eu beau les avoir etudiees, j'en suis encore a ignorer ce qui est parmi elles un bon, ou un mauvais procede. quoiqu'il en soit j'ai vu quelquefois celle qui vouloit etre portee se placer en face de celle qu'elle vouloit charger de son poids, lui mordre tantot l'une tantot l'autre de ses antennes, quelquefois la tete quelque fois les jambes anterieures, les coups de dents legers pouvoient bien n'etre que des caresses; mais ce qui n'etoit pas aussi surement une caresse c'est que j'ai vu quelquefois celle qui n'avoit pas envie de marcher saisir par une jambe de derriere la fourmi qui fuioit devant elle et l'obliger a s'arrester pour pouvoir venir se metre en face delle quand la premiere se trouvoit dans cette position le traite etoit bientot conclu.

*dans d'autres temps j'ai observe au contraire plus d'une fois une fourmi officieuse, peutetre a l'exces, qui en obligeoit une autre a se faire porter; la premiere mordoit les jambes, la tete, le corps de la seconde jusques a ce quelle presentast ses dents aux siennes, et que l'engrainement reciproque des dents fut fait. des qu'il l est celle qui doit etre portee se contourne en arc et l'autre part. les porteuses sont des fourmis ouvrieres, et je crois que les portees sont des masles.**

** Obs. Q. si ces porteuses ne seroient point des masles.*

j'ai pourtant vu quelquefois que la fourmi qui portoit n'etoit pas plus grosse. que celle qui etoit portee c'a ete surtout parmi des fourmis qui se disposoient a quitter leur fourmillere que j'en ai vu qui en forcoient d'autres a se laisser porter, peutetre parcequ'elles apprehendoient qu'elles n'eussent pas volonte de les suivre dans la nouvelle habitation, ou qu'elles ne scussent pas la trouver.

lorsque les fourmis ne sont pas dans la nescesite de s'occuper a reparer les desordres faits a leur habitation, elles n'en restent pas plus oisifves elles travaillent a laggrandir en circonference et a l'elever. y portent sans cesse des materiaux qu'elles y arrangent etc. elles [ne] connoissent de jours de repos que ceux ou la pluie les force de se tenir tranquilles. elles mettent meme a profit les belles nuit. elles ont aussi des heures dans le jour pour leurs courses etc.*

les environs d'une fourmillere ont en petit comme ceux d'une grande ville, des chemins qui en partent et qui se dirigent de differents cotes, et plus frequentes que les chemins d'aucune ville, pendant tout le jour les files de fourmis ne sont pas interrompues dans quelques uns, cependant ces petits insectes ne s'y embarassent aucunement les uns les autres, ceux qui vont a la campagne ne font aucun obstacle a ceux qui retournent a l'habitation une fourmi ne s'arreste alors que dans le cas ou son secours peut etre nescesaire a quelqu'une de ses compagnes; comme lorsqu'elle en rencontre qui ont trop de peine a remuer quelque pesant fardeau alors elle leur preste la main.[97] *mais lorsque deux fourmis se rencontrent en des routes detournées, ils semblent qu'elles aient quelque chose a se dire, elles s'arrestent toutes deux, l'une approche sa tete de celle de l'autre, on seroit tente de croire qu'elles se rendent compte reciproquement de ce que leurs courses leurs ont offert de digne de scu.*

les chemins ne sont pas seulement reconnoissables par les files des voyageurs qui les parcourrent; ils le sont par eux memes, ils paroissent frayes; a force d'etre piettines quoique par de tres petits pieds ils deviennent moins raboteux; et alors meme qu'ils passent autravers d'un gazon, ce qui leur est fort ordinaire, on les distingue tres bien du reste, en ce que le gazon y paroit moins fourni, et que

* *A verifier.*

les feuilles y sont plus ecartees les unes des autres. pline[98] pretend que les fourmis a force de passer et de repasser sur les cailloux qui se trouvent dans leurs chemins elles les creusent, il cite meme ce fait comm'un exemple de ce qui peut etre produit par des actions souvent repetees quelque faibles qu elles nous paroissent; cet exemple n'est pourtant pas aussi sur que celui [que] nous offrent les pierres des seuils des portes des lieux tres frequentes, il est plus certain que le frottement de nos soulliers vient a bout de creuser des pierres de taille, qu'il ne l'est que celui des pieds des fourmis produit cet effet sur les cailloux.

on scait que ces insectes laissent sur les corps qui les ont touche une odeur qui approche de celle du musc, et qui est mieux designée par le nom dodeur de fourmi, connu de tout le monde; elle nous deplaist lorsque nous la trouvons aux fruits qu'elles ont ronges et elle nous deplaist encore plus quand nous la trouvons a des comp[o]tes, et a des confitures sur les quelles aiant ete conduites trop avant par leur goust pour la friandise, elles ont ete prises comm'a la glu et ont peri. assez generalement cet odeur paroist desagreable; mais celle qui frappe l'odorat, lorsqu'on approche le nez d'une fourmillere qu'on vient de decouvrir n'est pas soutenable a 6 a 7 pouces de distance. on est forcé d'eloigner son nez dans l'instant, comm'on est force de l'eloigner d'une bouteille d'esprit volatil qui lui est presentee apres avoir ete debouchee. l'odeur que repand alors la fourmillere est si penetrante qu'elle excite sur le champ des eternuements.

ce fait nous apprend qu'il s'exhale continuellement du corps des fourmis beaucoups d'esprit volatil[99]; il leur est particulier, ou du moins ne leur est il commun qu'avec peu d'autres insectes d'en donner un si penetrant et en si grande quantite. si l on etoit dispose a croire que d'autres insectes rassembles en aussi grand nombre feroient sur notre odorat une aussi forte impression, pour desabuser on auroit qu'a se metre a portee de sentir d'aussi pres les abeilles d'une ruche ce qui se peut faire sans risque en bien des temps, apres avoir ouvert une des fenestres de celles qui sont vitrees. on ne sentira alors qu'une odeur qui n'est pas propre aux abeilles, que l'odeur de cire que repandent les gateaux, meslee avec celle du miel

qu'ils contiennent. les abeilles que j'ai tenues en grand nombre mais seules dans des sechoirs,[100] *ou dans des especes de vases de toile a tamis, pour des experiences qui ont ete rapportees ailleurs, ont cependant repandu un odeur desagreable en quelques circonstances, mais dont la force n'approchoit pas de celle qui transpire des fourmis.*[101]

comm'il n'est guere a presumer que les insectes qui par la transpiration fournissent plus de sel volatil, soient ceux dans l'interieur des quels il en reste moins, il sembleroit que la poudre de cloportes[102] *que l'on donne pour differentes maladies, a cause du sel volatil qu'elle contient, ne doit pas etre aussi efficace que celle des fourmis. les cloportes repandent peutetre moins d'odeur qu'aucun autre insecte mais ils sont plus gros que des fourmis, et la facilite qu'on a* [*à*] *en prendre en assez grande quantite dans des caves a probablement determine a les employer preferablement a beaucoup d'autres insectes dont il est plus difficile de se fournir. mais le sel volatil des fourmis ne conviendroit pas pour les cas ou conviennent ceux des autres insectes; s'il est certains comme des chimistes nous l'assurent qu'il est d'une nature particuliere quil est un seul acide, au lieu que les autres sels volatils si on en excepte celui du karabe*[103] *sont alcalis.*

aureste on ne doit pas reprocher aux anciens medecins davoir neglige de faire usage des fourmis, ils en ont aumoins indique des preparations comme dexcellents remedes contre un grand nombre de differentes maladies, dont je ferois inutilement ici l'enumeration.[104] *des medecins d'un ordre beaucoup plus bas que les notres, les marechaux sen servent journellement pour guerir les chevaux qui jettent, et qu'ils veulent empecher de devenir morveux. un marechal du poitou d'une habilete reconnue pour la guerison de leurs maladies, pour guerir un des miens qui jettoit considerablement, fit metre dans un tonneau plein d'eau tout ce qu'on put prendre de fourmis de vers et de nymphes dans une grande fourmillere, on prit ces insectes pesle mesle avec les brins de bois dont elle etoit composee. il fit boire mon cheval pendant quelques jours de cette eau, au bout desquels il fut gueri. mais la guerison etoit elle due au remede? c'est*

ce qui n'est pas plus facile de decider par rapport a ce cas, que par rapport a beaucoup d'autres qui nous interessent beaucoup plus.

pendant toute l'annee on peut avoir dans ce pays des fourmis de l'espece de celles qui batissent avec des brins de bois. quand le froid commence a devenir considerable, elles se rassemblent au fond de la fourmillere; c'est la qu'elles passent l'hiver, et d'ou il ne leur arrive de sortir tant qu'il dure, qu'en tres petit nombre, et dans des jours ou un soleil brillant a beaucoup echaufe leur habitation.[105] *mais pendant l'hiver les fourmilleres construites de terre rapportees ou creusees sous terre deviennent desertes. on a beau chercher dans leur interieur on n'y trouve pas une seule fourmi. ou se tiennent elles alors? c'est ce que je ne scay pas encore assez. selon tout apparence elles vont se loger bien avant en terre, a une profondeur ou le froid ne scauroit penetrer. il ne m'est pourtant jamais arrive d'en trouver dans cette saison dans les fouilles que j'ai fait faire soit pour planter des arbres, soit dans d'autres vues. se logeroient elles encore plus bas que ces fouilles n'alloient? lors qu'on laboure vers le commencement du primptems on n'en trouve pas davantage. mais des que les beaux jours on commence a revenir on les voit paroitre, les jardiniers meme pretendent qu'elles en annoncent la continuation alors elles recommencent a se fouiller des logements sous terre, ou a s'en batir sur sa surface de grains reunis ensemble. j'ai ete etonne que celles qui pendant le belle saison avoient scu se loger entre les carreaux et les volets de mes ruches vitrees ne se fussent pas tenues pendant l'hiver dans une si bonne place, ou en pouvoient elles trouver une plus chaude? peutetre aussi est elle trop chaude pour elles dans une saison ou elles pourroient perir de faim, s'il se faisoit chez elles une transpiration qui demandant qu'elles mangeasent alors elles ne trouveroient sur terre ni insectes, soit morts ou vivants, ni fleurs, ni fruits succulents.*

NOTES

FOURMIS. 1744. 8^E AOUST.

hier sur les sept heures du soir je fus frappe de la quantite de fourmis qui se trouvoit sur les tuilles du toict qui couvre l'entrée de l'escalier de la cave [de] mon potager. comme le bord du toict est bas, a peine a la hauteur des yeux d'un homme de taille ordinaire, il etoit aise de voir ce qui se passoit sur ce toict, dans la surface quarrée est d'environ. . . .[106] *la plupart des tuilles et surtout celles des cinq a six rangs les plus proches du bord etoient couvertes de fourmis, il en sortoit continuellement de dessous les tuilles ou avoit ete leur habitation. il en sortoit aussi des crevases qui se trouvoient dans le mur assez pres du toict.*

ces fourmis etoient d'une petite espece, mais non cependant de la plus petite. elles avoient la jonction du corps au corcelet rougeatre.[107] *le nombre des aislées y etoit plus considerable que celui des non aislées, et il en avoit autant de grandes aislees que de petites. a chaque instant on en voioit sortir quelques unes soit de celles ci soit de celles la d'entre les tuilles. leur quantite n'augmentoit pas sur le toict cependant dans le rapport du nombre de celles qui s'y rendoit, ou plutot elles n'y augmentoit point du tout. d'instant, en instant on en voyoit qui prenoient l'essor; et qui s'elevoient tres haut en l'air. la soiree etoit belle pendant tout le jour le soleil avoit lui, le thermometre n'avoit cependant monte qua 21½. jusqu'apres le coucher du soleil je vis des fourmis partir de dessus le toict, et je n'y en voiois arriver aucune en volant, c'est a dire qu'il n'y en avoit que de celles qui sortoient de dessous les tuilles. je les quittai quand je vis qu'il ne faisoit plus assez clair pour les observer.*

m'attendant quelles devoient revenir sur le toict apres avoir ete fecondees en l'air, je retournai visiter ce toict a 10 heures du soir

avec des bougies. je n'y trouvai pas une seule fourmi aislée, et a peine en pris-je quatre a cinq de celles qui n'ont pas d'aisles. j'y suis retourne ce matin huit a 7h½ l'habitation si etonnement peuplée 12 heures auparavant etoit entierrement deserte.[108]

sur cela il y a deux questions a faire scavoir si toutes les fourmis partoient lorsque [je les] vis pour aller toutes ensemble s'etablir dans un autre lieu. ce lieu avoit il ete choisi par les fourmis ouvrieres, ou par les aislées et dans ce cas comment les uns et les autres en avoient elles connoissance si elles partoient toutes en une troupe comme les mouches d'un essaim d'abeilles, il n'y a nulle difficulte mais les unes etoient parties de ma connoissance une heure plus tard que les autres et reellement peutetre plusieurs heures.

ne seroit ce point plustot qu'il se fait alors une dispersion des fourmis, que chaque couple masle et femelle va commencer une fourmillere et qu'au lieu qu'une ruche ne fonde qu'une famille dans un essaim.[109] *il y a pour ainsi dire parmi les fourmis une infinite d'essaims qui ne sont que d'un masle et d'une femelle. mais que deviennent alors les ouvrieres se partagent elles pour chaque couple ou continuent elles de vivre ensemble.*

toutes ces fourmis aislees etoient elles nées le meme jour? il n'y a pas d'apparence. que[s]t ce qui les determine un certain jour a se separer toutes? . . .

FOURMIS A FOURMILLERES EN BATON.[110]

des le commencement d'avril et meme je crois plutot j'ai trouve des coques filees au fond d'un des poudriers ou j'avois mis en janvier des fourmis apportees de St Maur. mais ce que je vis avec plus de plaisir ce fut un paquet d'oeufs gros comm'un poids pour le moins. mais les fourmis que j'inquietai par les mouvements que je donnai au poudrier, prirent bientot le parti de le diviser en differentes parties qu'elles emporterent dans des endroits de la fourmillere ou ils furent caches a mes yeux. ces oeufs etoient un peu oblongs d'un blanc luisant, et tel que celui qu'ont touts les autres oeufs de fourmis. il me semblent qu'ils etoient un peu plus pointus par un de

*leurs bouts que par l'autre. il est donc certain que les grosses fourmis de cette fourmillere les avoient pondus. je ne les ai pas pu voir depuis.**

ces fourmis vers le commencement de may etoient dans un etat qui faisoit pitie elles paroissoient tout couvertes de galles, jusques sur leurs yeux. chaque galle etoit une espece de mitte ces galles etoient placées differement sur differentes fourmis, les unes en avoient plus et les autres moins, mais il n'y avoit aucune qui n'en eut au moins 10 a 12 et quelques unes en avoient plus de cent, ces mittes d'un blanc jauneatre.[111] *le sucre qui etoit dans le poudrier avoit fourni un bon aliment aux meres. j'en ai compte pres de 30 sur un seul coste de la teste d'une fourmi. on juge de la qu'il y en avoit d'extremement petites;* R. *cet article pourra etre gardé pour l'article des mittes.* R. *Mr Lyonnet theologie des insectes,*[112] *dit qu'il a vu des mittes vivipares, et doute si elles ne le sont pas toutes.*

je ne scay si les fourmis rendent des excréments? ce qui paroist certain c'est qu'elles n'en rendent que tres peu, et point de solides je n'en ai trouve ni dans les fourmilleres de terre ni dans celles de petits bastons.

FOURMIS.

il faut pourtant convenir qu'il y a des fourmis qui font quelques petits desordres dans nos jardins, il [*y*] *en a qui aiment certaines fleurs avant qu'elles soient epanouies. hier 14 juillet 1743. je remarquai des fourmis sur differents pieds de ces grandes mauves nommées roses trenières, et dont les fleurs sont plus grosses que les grosses roses.*[113] *les unes donnent des fleurs blanches, et les autres en donnent de rouges. ce fut sur trois pieds a fleurs blanches que je vis des fourmis. il y en avoit des 20e attro*[*u*]*puées sur de gros boutons qui n'etoient pas encore epanouis, dont les petales etoient couvertes par les feuilles vertes du calyce. je remarquai bientot que des portions de quelques unes de ces dernieres feuilles avoient ete*

* *Obs. 1744. il n'y a pas de doute que les fourmilleres a batons ne subsistent plus d'une année j'ai trouve le 29 juin sur une barriere de la forest de bondi l'establissement que j'y avois observe l'annee derniere.*

rongees; ce n'etoit probablement que pour parvenir a celles de la fleur. car les fourmi avoient creuse dans la masse de ces dernieres.

ces fourmis sont d'une grandeur au dessus de celle des plus petites qui travaillent en terre. elles sont presque noire et luisantes.

Obs. si dans l'interieur des boutons il n'y a pas quelque chose qui les attire.

FOURMIS NOIRES DE LA PLUS PETITE ESPECE DE CELLE QUI TRAVAILLENT EN TERRE.[114]

j'ai commence a les observer le 12 may 1743.

il n'est point de fourmis plus laborieuses et qui expedient la besogne plus diligemment.

le travail qu'elles ont fait dans le poudrier a ete different de celui qu'elles font en pleine campagne; le plus souvent la terre est percee de plusieurs trous dans chacun des quels le pouce pouvoit entrer. ils etoient separes les uns des autres par des cloisons elevees, par des especes de monticules. ces cloissons ces monticules, tomboient, les trous etoient remplis pour peu que j'agitasse le poudrier lorsque je le changeois de place, c'est ce qui arriveroit aux fourmilleres exposées a l'air des que le vent soufleroit dessus.

hier dans je jardin les fourmis [de] cette espece tenoient en plein midi, et devant et apres leurs vers et nymphe a un pouce et demi ou environ du haut de la fourmillere. pendant ce meme temps les miennes tenoient les leurs sur le fond du poudrier.

elles sont aisees a nourrir parcequ'elles aiment extremement le sucre. elles couvrent de terre les morceaux de celui qu'on leur donne. je voulois qu'elles vinsent en prendre qui fut a decouvert. j'en suspendis un gros morceau au moyen d'une ficelle qui l'entourroit. un bout de la ficelle qui formoit l'anneau etoit assez long pour toucher le poudrier et pour faire un pont aux fourmis pour arriver au sucre; elles s'ennuierent apparemment d'avoir ce chemin a faire. le lendemain je ne vis plus le morceau de sucre ou je l'avois suspendu, elles avoient pris le parti de ronger la ficelle qui le tenoit en l'air, et il etoit tombe. c'avoit ete un travail pour les fourmis que de

ronger cette corde. on ne scauroit s'empecher de reconnoitre le fin pour laquelle elles l'avoient fait, et de voir qu'elles scavent agir differement selon que les circonstances le demandent.[115] *car les fourmis ne sont point en usage de couper les supports sur les quels se trouvent des aliments qu'elles aiment.*

je les ai mesurées avec soin. les ouvrieres qui sont les seules qu'on voye actuellement sont extremement petites; leur longueur n'est auplus d'une ligne et $\frac{1}{4}$. *aussi vue avec ma loupe ordinaire ne paroissent elles pas aussi grandes a beaucoup pres que nos fourmis de fourmilleres de batons. je les ai dit noires mais vues a la loupe elles paroissent seulement d'un brun tres fonce.*

elles meritent plus qu'aucune autre d'etre observée non seulement par la facilite qu'on a de les nourrir, mais surtout par ceque touts leurs maneges sont aises a suivre dans les poudriers.

leurs vers sont de ceux que j'ai dit ailleurs etre faits en cornemuse. ou sil l'on veut ils ont quelqu'air d'un oiseau sans aisles, et sans jambes, et sans plume, je veux seulement dire que leur partie anterieure forme une espece de col d'oiseau au bout duquel est une teste qu'on croit voir terminee par un bec.

le corps des vers est toujours humide et meme gluant est il rendu tel par la matiere qu'il transpire ou ne doit il pas plutot la liqueur dont il est humecte aux nourrices qui prennent soin d'eux ce qui est certain, c'est qu'elles lechent les vers continuellement, il y en [a] quelquefois quatre a cinq a la fois d'occupées a lecher les vers qui doivent devenir aisles, qui sont de grosses masses par rapport aux fourmis ouvrieres. il est plus naturel de penser que les fourmis qui lechent des vers cherchent a les tenir enduits d'une liqueur qui leur convient, qu'il ne l'est qu'elles cherchent a leur oter une liqueur superflue a les secher. la langue de nos fourmis qui fait passer du sucre ramolli dans la bouche, ne doit pas paroitre propre a secher des corps.

outre les avantages que cette liqueur dont le corps des vers est humecte leur procure elle est commode pour leurs nourrices; ses effets prouvent qu'elle est visceuse. les ouvrieres mettent quelquefois des vers en tas qui tiennent touts ensemble. j'ai vu l'effet de cette

liqueur gluante dans une circonstance dont j'aurai a parler j'ai [vu] quelquefois la plupart des vers tres hors de terre et attaches contre les parois du poudrier. non seulement la viscosite de la matiere resistoit a tout l'effort du poids du ver, souvent deux ou trois autres vers etoient colles a celui ci sans toucher en aucune façon aux parois du poudrier.[116]

quand les fourmis tiroient leurs vers de la terre pour les coller aux parois du poudrier elles le faisoient sans doute pour de bonnes raisons, mais d'autant plus difficiles a deviner, qu'elles n'etoient pas generales pour touts les leurs. ce qui le prouvoit c'est que j'ai [vu] souvent des tas qui etoient sur le fond du poudrier, et qu'on ne songeoit pas a en oter. ceux la seuls qui etoient trop humides, qui pour etre plus sainement, et pour devenir en etat de croitre avoient besoin d'etre portes au grand air avoient ete attaches aux parois; quelquefois ils ont ete colles presque touts, et souvent il n'y en a eu qu'une assez petite partie. d'autrefois, et surtout lorsque le fond du poudrier avoit ete trop mouille, j'ai vu les ouvrieres se contenter d'apporter leurs vers sur la couche superieure de la fourmillere mais si elles vouloient les metre plus sechement, elles ne vouloient pas qu'ils le fussent trop; des que je faisois tomber les rayons du soleil sur le poudrier elles songeoient a metre les vers a couvert de son action elles les rentroient elles les portoient sous terre c'a ete dans de pareils moments qu j'ai vu dix a douze fourmis autour d'un seul de ces vers dont le poids est enorme par rapport a celui de chacune d'elles. de concert elles travailloient a le pousser dans quelque cavite ou il put etre a couvert.

PETITES FOURMIS.[117]

quand la terre a ete applanie par les seccousses qu'on lui a donnees elles travaillent alors a faire un grand nombre d'entonnoir. chacun est un chemin qui conduit au fond du poudrier. plus il y a de ces chemins plus il est facile de trouver les vers de les retirer pour ainsi dire de dessous les décombres. mais quand ils ont ete touts retrouves et loges elles diminuent chaque jour le nombre des entonnoirs.

en moins d'une heure je leur ai vu creuser plus de 15 a 16 entonnoirs dans un poudrier de quatre pouces et quelques lignes de diamètre et les jours suivants il n'y en avoit que deux ou trois.[118]

le fond du poudrier est le lieu ou elles tiennent le gros des vers. la elles menasgent des voutes sous les quelles elles les posent elles mettent sous ces voutes des pierrailles des brins d'herbe seche, afin que les vers soient plus eleves que le fond, assez souvent elles les posent sur le fond meme.

le soin que les fourmis ont des petits elles l'ont des oeufs. nous avons dit que les oeufs sont empaquetés et qu'ils croissent n'es ce point la liqueur dont les fourmis les enduisent qui les tient colles les uns contre les autres, et cette liqueur ne fournit elle point a leur accroissement. quelqu'etrange que soit le soupcon on peut peutetre le former. peutetre faut il eclaircir si ce n'est point par la peau que les vers prennent leur nourriture et si l'analogie n'etoit pas conserve entr'eux et les autres insectes, elle le seroit entre ces vers et leurs oeufs d'ou ils sortent. mais il est difficile de s'assurer que les nourrices ne portent rien a la bouche des petits.

l'affection de ces nourrices nest elle que pour les vers qui sont nes avec elles, que pour ceux de leur famille, ou s'etend elle a touts ceux de leur espece.[119] *aiment elles assez tendrement et generalement leur espece pour etre disposés a prendre pour les vers nes dans une autre fourmilleres les memes soins qu'elles prennent pour ceux de la leur? pour m'en instruire j'ai ote une douzaine de vers ou environ a une fourmillere etablie dans un de mes poudriers, et apres avoir chasse toutes les fourmis qui s'etoient laisse enlever avec eux et qui ne vouloient pas les abandonner. j'ai mis ces vers dans un poudrier ou il y avoit une couche de terre d'un pouce d'epaisseur ou environ, et j'ai fait passer dans ce poudrier environ une centaine de fourmis prises dans un poudrier different de celui d'ou j'avois ote des vers. avec ces fourmis que j'avois separees de leurs compagnes, je mis un seul de leur ver, pour voir s'il seroit autrement traites que les vers etrangers. elles m'apprirent bientot que c'est le bien general de leur espece qui les anime, qu'elles ne se passionnent pas pour les seuls vers de leur famille. le ver qui etoit de celle des 100 fourmis, ne fut*

pas mieux traite que les vers qui etoient etrangers pour elles touts le furent bien on travailla a leur preparer un logement, on prepara une cavite au fond du poudrier ou ils furent touts portes. plusieurs de ces vers montroient par leur grosseur qu'ils etoient de ceux qui se devoient transformer en grosses fourmis aislées. il resteroit peutetre a examiner si elles prendroient les memes soins des vers qui donnent des fourmis ouvrieres.

PETITES FOURMIS.

Exp. la belle experience et qui me donner[a] la suite complete de l'histoire des fourmis ce sera de metre dans un poudrier une mere sans aisles, et dans un autre plusieurs meres avec nos petites fourmis ouvriere les meres sans aisles auront probablement ete fecondees etc.[120]

GRANDES FOURMIS DE MONTIGNY.[121] *5 Juin 1743.*

je trouvai hier, a montigny les plus grandes fourmis que j'aie vue dans le Royaume. leur longueur et leur grosseur me frapperent. je les ai mesurées, elles ont pres de neuf lignes de long. et leur ventre est gros a proportion. je les crus des femelles des fourmilleres a brin de bois, mais leur espece est differente de l'autre. je n'observai aucune fourmilleres faites de brins de bois. toutes les fourmis que je du juger etre en societe avec celles d'une grosseur si considerable, entroient dans la terre relevée sur le bord d'un focé ou il y avoit quantite de sentes, et ou les fourmis paroissoient avoir fouille.

avec ces grosses fourmis j'en observai et j'en pris d'une grandeur inferieure a la leur quoique considerable encore que je regarde comme les masles. elles ont 6 lignes de longueur. je negligeai de prendre des ouvriers. je le ferai aujourdui.[122] *les femelles ont la teste et le corcelet d'un brun presque noir leur corps est d'un marron clair.*

je les mis dans un tube de verre ou j'en couvris une de terre elle n'en sortit point. il semble qu'elle n'avoit pas scu fouiller parmi elles les ouvrieres sont chargées apparemment de tout le travail des fouilles.

je crois qu'elles vivent de plantes, ou d'insectes. elles n'ont pas paru faire cas du sucre que je leur ai donne.

*dans le tube il n'y avoit que deux femelles et deux masles ou ouvrieres. les deux femelles se portent bien mais ces deux masles ou ouvriers sont morts. un des deux est cependant encore en etat de faire faire quelques petits mouvements a une de ses jambes, mais qui ne suffiroient pas meme pour le retourner d'un cote sur l'autre. les masles sont ils plus delicats que les femelles, ou ont il ete tues par celles ci? ce n'a pas ete au moins pour les ronger; ils n'avoient aucune blessure au ventre.**

quoique ces grosses fourmis aient des dents ou serres assez proportionnées a leur grandeur elles ne mordent pas aussi fort, ou leurs morsures ne sont pas aussi sensibles que celles de fourmis beaucoup plus petites; chaque dent a cinq dentellures ou cinq petites dents.

la pression a fait sortir du derriere des masles cinq petits corps, je ne suis pourtant pas bien sur du nombre dont quatre doivent etre les accompagnements de celui qui est destine a la fecondation des oeufs.

ce que j'ai nomme jusqu'ici les masles sont les ouvrieres. j'allai hier 5 examiner les nids. ils sont quelquefois indiqués comme ceux des guespes, ou des abeilles souterraines par un trou bien rond dont le diametre est tel que celui des trous dans lesquels entrent les mouches dont nous venons de parler. aiant vu quelques uns de ces trous dont le bord etoit un peu labourés, je les soupconnai etre les entrées des habitations souteraines des grosses fourmis. j'avois inutilement cherche de ces habitations les fourmis n'etoient pas en aussi grand mouvement que la veille, il ne faisoit pas si chaud il pleuvoit meme. mais les trous dont je viens de parler me conduisirent a les trouver. aiant fait enlever la terre je trouvai que les ouvertures etoient celles de trous qui penetroient sous terre, ils etoient tortueux et se ramifioient de temps en temps. en quelques endroits ils devenoient plus evasés ils formoient des cavites plus spacieuses de forme irreguliere qui avoient quelquefois un pouce de diametre et quelquefois deux ou trois

* *R. le 7e juin une des femelles qui etoient dans le poudrier a eu le corps coupe. ce corps a ete porte, et reporte par des fourmis de l'apres midi jusqu'au matin suivant, la fourmi avoit elle ete tuée. il restoit encore plusieurs meres.*

pouces. je trouvois dans chaque conduit une ou deux fourmis et pas davantage je les croiois peu peuplees mais j'arrivai enfin a la veritable habitation qui etoient d'environ deux pieds plus bas que le bord du foce. la etoit un vieux tronc de racine. ce tronc avoit ete reduit en feuillets de figure irreguliere, et bizarement contournes. les dents des fourmis avoient forme ces feuillets elles avoient creuse les racines.

dans des habitations que je ne fouillai pas aussi avant que la precedente je trouvai des vers de differents ages, mais aucun en coque ou en nymphe. ils etoient dans des endroits assez eleves sous de petites voutes de terre.

la saison ou nous sommes est peutetre celle ou les meres commencent des etablisements. ce qui me dispose a le croire c'est que je trouvai une mere, et elle fut la seule que je trouvai hier dans un trou qui etoit un cul de sac et qui n'avoit pas deux pouces de profondeur. les parois de l'endroit le plus evase etoient tapisées c'est a dire qu'il y avoit la une coque de soye dont les parois etoient assez epaises grisatres et terreuses. rien ne me parut prouver qu'elle eut ete filée par la fourmi. j'avois plus d'apparence qu'elle l'avoit ete par quelque chenille, et que la mere fourmi en avoit profite pour commencer son etablisement.[123]

la pluie qui m'obligea de m'en retourner ne me permit pas de chercher assez pour trouver les vers de la fourmillere que je suivis jusques a la racine d'arbre, je ne parvins pas aussi a trouver des meres. cette recherche sera pour aujourdhui.

ces fourmis mordent fort bien quand elles ont ete irritees elles sont pourtant plus douces plus patientes que les ordinaires.

7 hier je defis la grosse fourmillere je mis a decouvert la racine que les fourmis avoient creusée par feuillets, et je ne vis rien de plus que la veille. je ne pu trouver aucune mere. elles meurent apparemment apres avoir fait leur ponte.[124] *les vers etoient par tas, mais loges en differents endroits, eloignes de plus de 3 a 6 pouces les uns des autres. en fouillant dans des trous du meme foce on trouva en deux trous differents deux femelles dont une etoit encore aislée. chaque femelle etoit seule dans son trou ce qui prouve qu'elles sont*

seules lorsqu'elles commencent des etablissements. je mis ces deux meres dans un poudrier avec quatre fourmis ouvrieres ou peutetre ouvrieres et masles? la plus petite tint ou fut tenue pendant tout le jour par la femelle non aislée. les pinces de l'une etoient passées alternativement entre celle de l'autre. tantot la petite forcoit la grosse a marcher vers elle et tantot la petite etoit entrainée par la grosse. etoient ce caresses ou combats je n'en scay rien! j'avois deja observe dans un autre poudrier une femelle et une fourmi plus petite qui se tinrent sans se quitter pendant plus de 5 carts d'heure. et je vis au bout de ce temps la petite qui apres s'etre separée de la femelle dont il s'agit alla en attaquer un autre avec les antennes ses dents se cramponnerent avec celle de la nouvelle femelles et je les vis ainsi attachées par les dents pendant plus d'un cart d'heure et je ne scay combien elles y resterent.

8^e^ juin les femelles sont tres luisantes, elles ont la teste, le dessus dn corcelet, et la partie posterieure du corps, noir. mais la partie anterieure du corps est marron; le dessous du corcelet est aussi de cette couleur. les ouvrieres ont le dessus du corcelet marron et moins maron a la partie anterieure de leur corps.

quoiqu'il y ait une femelle dont le corps a ete coupe, il en reste au moins deux ou trois autres dans le poudrier qui ne sont pas inquiettees ou caressees comme le premier jour; dont les serres ne sont plus prises entre celles d'un autre fourmi les deux femelles que j'ai mises avec quatre fourmis ordinaires sont aussi tres tranquilles. celle qui a ete prise avec des aisles les conserve encore.

6^e^ JUIN FOURMIS DONT LES FOURMILLERES SONT DE BRINS DE BOIS.

je ne connoissois encore qu'une espece de ces fourmis, mais hier j'en vis deux qui ne different pas sensiblement en grandeur. celles que j'observai hier ont le corps plus gris, moins noir que celui des autres.[125] *les vers de l'ancienne espece de celle qui m'est connue de tout temps se filent des coques rousses. aulieu que les vers des fourmis de la nouvelle espece s'en font de tres blanches.*

on a marque avec des piquets enfoncés en terre cinq fourmilleres une dans la grande avenue qui n'est pas fort grosse, au commencement de l'avenue a droite en entrant, et les autres dans la premiere allee a droite, et sur le bord a droite celles ci sont extremement grosses.

FOURMIS.

pison [126] *edition 1658. pag. 291 est un long article des fourmis. la il dit qu'il a observe qu'elles acquierrent et deposent leurs aisles.*

Marcgrave[127] *edition de 1648 pag. 253 dit que la fourmi appellée Cupia acquiert des aisles, et qu'elle les perd ensuite, ce qu'il a vu pour etre vray ne doit tomber que sur le temps ou elle les perd.*

FOURMIS.

[Rayger][128] *Mu. curis naturae. 3 decen. pag. 27. fourmis aislees. ob. 21 il cite Bontius*[129] *sur les remarques de Garcias Aberto pour les fourmis qui donnent la lacque.*

il cite aussi Margrave livre 7 de son histoire du Bresil sur les prodigieuses fourmilleres.

la on dit qu'il est hors de doute que les aisles poussent aux fourmis ordinaires dans leur viellesse, il parle ensuite, c'est Raygeras, de fourmis qui parurent en prodigieuse quantite et qui tomboient a terre et y perdoient leurs aisles, qu'il en ramassa et les mit dans une bouteille ou elles tomberent sur le cham acta ph. eph. vol. 2. an. 1730 pag. 304. de l'huile etherée des fourmis.

a la suite du travail du jour je ferai remarquer que les grandes fourmilleres n'ont qu'un certain nombre de portes, et que les fourmis les bouchent toutes lorsqu'elles veulent se retirer chez elles.[130]

les fourmis soufrent impatiemment qu'on les prenne, elles mordent alors le plus fort qu'elles peuvent, et mordent bien aiant de tres bonnes longues et larges dents. maïs les dent de celles de quelques especes ne sont pas ce qu'on a le plus a redouter, elles sont armées precisement comme les abeilles et les guespes, elles ont un aiguillon.

ordinairement ne se defendent contre nous qu'avec leurs dents, mais il y en a des especes, et une entr'autres dont a parle leuwenhoek[131] *qui ont des aiguillons. la mienne n'est pas la sienne.*

une de mes remarques est que j'ai vu travailler au mois de juin dans un fourmillere de brins de bois, les fourmis plus petites que les ouvrieres, et qui sont probablement des masles qui ont perdu leurs aisles,[132] *et que je n'ai point vu travailler les meres soit aislees, soit non aislees a transporter des morceaux de bois.*

une fourmi jettee dans une fourmillere est bientot environnees de plusieurs fourmis qui semblent la mordre les unes au corps les autres a la tete, manege qui dure quelquefois plus d'un cart d'heure, sans que celle qui est attaquée prenne le parti de s'enfuir. peutetre lui fait on des caresses. jamais on ne la tuee, et elles tuent les chenilles.

ajouter a l'endroit ou j'ai parle de leur amour pour leur fourmillere que celle de ma cloche de verre, qui perirent sur le couvercle n'es ce point plutot que le couvercle etoit devenu le cimetiere.

s'il n'y auroit point des accouplements en l'air et d'autres dans la fourmillere, et si ceux pour lesquels les aisles sont nescesaires ne donneroient pas des fourmis d'une sorte differente.

le 26 juin 1734[133] *je donnai la liberte aux fourmis a fourmillere a brins de bois, que je tenois renfermees depuis plus d'an, il y en avoit pourtant parmi elles qui pouvoient ne l'etre que depuis la touts saint precedente je trouvai dans la cloche, ou je n'avois mis aucune fourmi aislée, plusieurs vers, fort gros mais qui ne s'etoient pas encore filé leur coque.*

cornes charnues observées en 1735 au derriere presse des petites fourmis non aislees des fourmilleres a brins de bois, que je n'ai pas trouve aux autres.[134]
espece de palette observe a la jonction du corps avec le corcelet des fourmis a brins de bois.[135]

j'ai observe deux stigmates tres distincts au dessus de chaque jambe de la derniere paire[136]*; j'en ai soupconne quatre plus proches de la tete.*

quand j'en serai a la description des fourmis relire pag. 69 et 70. Ray.[137] *celle de Swammerdam y est.*

les fourmis qui se rencontrent se donnent a manger. l'une presente sa langue qui est lechee par celle de l'autre.[138]

dessein qui restent a faire. 1° une fourmillere de brins de bois. 2° la tete d'une fourmi en grand et ses dependances. 3° fourmis assise sur son derriere qui presche. 4° fourmi qui en porte une autre. 5° fourmi porte en l'air devant elle un brin de bois. 6° fourmi qui a reculons traine un brin de bois trop pesant. 7° plusieurs fourmis apres le meme brin de bois.[139]

observations qu'il me reste a faire sur les fourmis dans les fourmilleres a brins de bois je ne scay pas encore bien distinguer les femelles je ne crois pas qu'elles y surpassent autant les ouvrieres en grosseur, que les femelles des autres fourmilleres surpassent les leurs. pour me metre bien en etat de reconnoitre des meres, il faut oter les aisles a des fourmis aislees de ces fourmilleres de brins de bois.[140]

en 1742[141] *j'ai laisse a reaumur, dans le chemin peu frequente qui va le long d'une haye du premier pont de la prairie au dernier moulin de la touche un fourmillere a brins encore tres petits, elles ne faisoit que commencer. elle est placée de l'autre cote de la haye sur le bord eleve du chemin vis a vis le sixieme arbre a commencer a compter du grand chemin. il s'agira l'année prochaine de scavoir si elle sera dans le meme endroit, et si elle sera grossie.*

j'en ai laisse une beaucoup plus grosse dans le champ de l'epremure ou j'ai fait planter des chesnes en allee.

en mettant plusieurs fourmis aislées qui se sont accouplées, il faut tacher de parvenir a voir tomber les aisles, pour etre sur qu'elles

tombent comme font les feuilles des arbres, que les fourmis ne se les arachent pas.

des fourmis meres sousterraines mises dans un tube mediocre en grosseur, seront plus aisées a observer, qu'elles ne l'etoient dans un poudrier quelqu'epaise que soit la couche de terre.

*si les fourmis soigneront les vers et les nymphes d'une autre fourmillere — l'experience sera aisée a faire sur les fourmilleres a baton.**

si elles travaillent au clair de la lune.
tenter de faire travailler sous mes yeux dans un poudrier des fourmis de bois, en leur tenant dans un poudrier, et leur donnant du bois pourri.

pour connoitre les gousts des fourmis de diverses especes, et voir ce qu'elles aiment le mieux il faut leur servir une table bien couverte de mets differents. cette table sera une assiete de fayance qui d'un cote aura des gouttes de miel, du sirop, de la compote, de l'autre des vers coupes, de la viande des scarabes, des mouches a miel ou guespes mortes des chenilles des araignees. cette table bien servie me servira aussi a faire l'experience pour apprendre si les fourmis s'avertissent je porterai une fourmi dessus, et sur une table pareille mise a pareille distance de la fourmillere je ne jeterai point de fourmis je verrai par la si les fourmis vont s'avertir et en combien de temps elles peuvent profiter de l'avis.[148]

metre dans une fourmillere des morceaux de resine pour voir s'ils y prendront une qualite particuliere qui les rapproche de la Mirre ou du succin.[149]

metre dans une fourmillere un papier bleu mouillé pour voir s'il y rougira.[150]

essayer d'avoir de l'esprit volatil en metant une cloche de verre dans une fourmillere.[151]

* *livres à voir, Pison, Vallisnieri,*[142] *Worton,*[143] *actes de Suede,*[144] *Power,*[145] *l'abbat fourmis de passage*[146] *le pere du tertre, leuwenboek histoire de St domingue.*[147]

le 10e de juin 1720. la nuit aiant ete tres belle, et la lune aiant eclaire pendant toute la nuit. j'ai ete voir mes grosses fourmis a 6, et 7 heures et demie du matin, il n'y en avoit presque point sur la fourmillere. c'est a dire peutetre une demi douzaine. elles ont leurs heures pour le travail, et pour le repos, elles avoient peutetre travaille toute la nuit. mais j'ai observe de plus que toutes les entrées de la fourmillere etoient bouchées, excepte une fort petite. a huit heures et demie une grande partie des fourmis paroissoit, elles etoient occupées [à] ouvrir toutes les portes, c'est a dire a transporter les petit morceaux de bois avec les quels elles les avoient bouche. il est a remarquer, que ce jour le soleil etoit brillant et chaud des le matin, ainsi ce n'etoit point le mauvais temps qui les avoit retenu si tard dans leur fourmillere.

vers le mydy, une heure et deux heures, quoique le soleil ne fust pas brillant qu'il fut souvent couvert de nuages, par consequent n'echaufast pas trop la fourmillere, presque toutes les fourmis etoient rentrees dedans, ainsi le midy, est encore un de leurs temps de repos.

POUR FAIRE PERIR LES FOURMIS.

*des que les fourmis aiment tant les lique[u]rs sucrés, le moyen en paroist facile. il n'y a qu'a empoisonner de l'eau ou du sucre est dissous. y dissoudre un peu d'Arsenic. on metra cette eau dans un vase au pied des arbres ou elles montent. l'eau pourra s'evaporer, mais elle laissera le suc et l'Arsenic, il n'y aura qu'a y remetre de l'eau.**

il faudra essayer les doses d'Arsenic les plus faibles capables de produire cet effet.[152]

peutetre qu'il suffiroit, et que ce seroit mieux de faire un sirop ou il [y] eut de l'Arsenic d en imbiber des linges, et d'en entourer les arbres; les fourmis iroient sucer le sucre, et s'empoisonneroient. lessive de cendre.

* *tout l'article qui regard la maniere de faire perir les fourmis est encore a faire, ou a retoucher, ce qui a ete fait a Cayenne par Mr Fresnau l'effet du savon, des lessives de cendres etc.*

SLOANE.[153]

FOURMIS

tab. 238. nid de fourmis de bois avec la gallerie couverte par laquelle, elles y arrivent.

LETTRE DE LYONET[154] À RÉAUMUR.

à la Haÿe ce 5 Decemb. 1743.

Monsieur

je vous demande pardon Si j'ai tant tardé à vous repondre; mais comme je Savois que vous etiez absent, et que vous n'aimez pas qu'on vous ecrive que lors que vous etes à Paris, j'ai voulu attendre votre retour, que je n'ai apris qu'un peu tard. Je prends la liberté Monsieur de vous envoyer les coques que vous m'avez demandé; vous ne vous atendiez aparemment pas à en recevoir de si petites; mais quelque petites qu'elles Soient, je me persuade que vous trouverez qu'elles meritent quelque atention. comme je n'en ai jamais trouvé que de toutes formées, je ne puis vous aprendre comment l'Insecte les construit. Celles dont les Oeufs ne Sont point encore éclos, Sont constemment gardées par une Araignée jeaunatre beaucoup plus petite que la coque même; l'Araignée[155] S'en tient ordinairement ecartée de la distance environ d'un pouce. je n'ai jamais trouvé ces coques qu'apliquées contre le dessous des feuilles de Chêne la pointe en bas, et quand j'en ai mis sur le dessus d'une feuille, l'araignée n'a pas manqué de les transporter à l'opposite. ce Soin prouve assez que ce Sont les coques de cet Insecte; mais ce qui m'empeche d'en pouvoir douter, c'est qu'ayant ouvert une de ces coques dans laquelle il y avoit 22 oeufs, j'ai vu Sortir de ces oeufs autant de petites Araignées, et ce qui me paru Singulier, c'est qu'après être Sorties de leur envelopes, elles demeurerent plus de 24 heures couchées comme immobiles avant de changer de place. J'avois essaié de les elever avec des mouches; mais n'en aÿant pas voulu manger, je les ai negligées et, elles Sont mortes.

Je desire fort de voir paroitre votre 7e Tome.[156] Les Scarabés

ont été peu etudier jusques ici, à cause de la dificulté qu'il ÿ a de les Suivre, et du tems qu'il faut pour cela. Je Suis persuadé, Monsieur, que vous aller nous introduire à leur egard dans un païs inconnu qui abonde en merveilles; mais j'ai de la peine à croire qu'il en Soit Si fertile que vous nous avez fait voir que l'est celui des mouches.[157] *Les Fourmis dont vous traiterez aussi, je crois, dans le même volume, n'excitent pas moins ma curiosité. Quoi que cet Animal ait été plus Observé que les Scarabés, on ne le connoit encor que très imparfaitement. J'ai une fois commencé à les Suivre; mais je n'ai pas continué; tout ce qu'elles m'aprirent alors de nouveau, c'est d'un côté qu'elles filent aussi-bien que leurs vers; et de l'autre, qu'elles n'admettent pas de fourmis étrangères, quoi que de la même espèce, à leur Société. ce qui me fit soubçonner qu'elles filent, c' st dabord les petites masses de terre qu'elles entassent autour de l'entrée de leurs Souterrains, et qui Sont chacune composées de plusieurs grains lier ensemble: J'ai vu que la fourmi pour les former amonceloit Sous Soi de Ses jambes et de Ses antennes les grains Separez qu'elle detachoit en creusant, et qu'apres les avoir ainsi amonceléz, ils tenoient les uns aux autres, et donnoient à la fourmi un moÿen aisé d'en transporter plusieurs à la fois hors de Son Souterrain; mais ce qui m'en fournit une preuve Sans replique, c'est qu'après avoir versé de l'eau dans un poudrier presque rempli de terre, le long des parois duquel mes fourmis avoient creusé, cette eau, entrant dans leurs Souterains, entraina le peu de terre que les fourmis avoient en bien des endroits apliqué contre le poudrier, et laissa à decouvert quantité de fils par lesquels cette terre avoit été assujettie.*[158] *Ce qui me fait conclure que les Fourmis n'admettent pas de fourmis etrangeres à leur Societé, c'est que j'ai deux ou trois fois jetté une fourmi étrangère, qui me paroiSSoit de la même espèce, dans un poudrier ou d'autres etoient établies, aussitot celle-ci après l'avoir examinée la barcelerent quelque tems, jusquà ce qu'enfin une de la troupe se detacha pour l'attaquer en combat Singulier, au même instant les autres S'ecarterent, et ces deux Se battirent Seul a Seul jus quà ce que l'une des deux ÿ perdit la vie: Je ne Saurois dire Si ce fut l'aSSaillante ou l'autre, parce que je ne l'avois*

point marquée; mais la victorieuse n'eut pas de nouveaux combats à eSSuier.[159] *Cette Sorte de bataille Se fait avec tant d'acharnement, que la fourmi vivante a Souvent mille peine de Se depêtrer de l'autre, qui toute morte qu'elle est, reste atachée par les dents aux jambes ou aux antennes de la première. J'ai ainsi vu que la tête d'une fourmi tuée que j'avois Separe du corps, à tenu plus de trois jours par les dents à l'antenne de la fourmi victorieuse avant que celle-ci S'en Soit pu debarraSSer. J'ai quelque regret de n'avoir jamais pu Saisir le moment que mes fourmis Sont Sorties de leur coques; cela m'a empêché d'éclaircir un fait dont j'etois curieux, Savoir, Si ce ne Sont pas les fourmis ouvrières qui ouvrent les coques de celles qui en doivent Sortir, comme je le Soubçonne; parce qu'il n'ÿ a eu que les coques gardées par d'autres fourmis qui m'ont produit des jeunes, et que celles que j'en ai tenu Separées Sont toutes mortes Sans eclorre; que d'ailleurs quand on examine les coques vuides on les trouve rompuës par morceaux et non pas ouvertes par l'un des bouts; et que les fourmis qui en Sortent Sont toutes blanches, ce qui donne lieu de presumer qu'elles se trouvent encore alors dans un état de faiblesse qui les empêche peut être de pouvoir ouvrir ellesmemes leurs coques. Si les fourmis n'en pouvoient Sortir Sans le Secours de leurs Semblables nous saurions pourquoi Swammerdam et d'autres auSSi bien que moi ont inutilement tenté de faire eclorre de ces coques, et ce Seroit une Singularité bien etrange qu'une fourmi ne Sauroit naitre Sans accoucheur.*[160]

J'espère Monsieur que vous me pardonnerez, Si je n'ai pu me reSoudre à envoÿer aucune addition ni correction a Mr Durand, pour les raisons que j'ai dejà eu l'honneur de vous marquer. Mr Durand auroit beau promettre de n'envoyer aucun exemplaire de Son edition en Hollande, il ne peut empecher que d'autres à qui il en fournira ne le faSSent. Aureste Monsieur vous me feriez tort de croire, que vous m'ayez fait, Sans le Savoir, aucun deplaisir en occasionnant cette seconde edition. Vous ne m'en avez point fait du tout, et je sens trop tout ce que votre procedé a eu d'obligeant à mon égard pour ne pas vous en avoir au contraire une très juste reconnoiSSance.[161]
J'ai bien des graces à vous rendre Monsieur, de la connoïSSance

que vous m'avez procurée de Monsieur le Comte de Serati. c'est un home d'esprit et de merite, dans la converSation duquel il ÿ a beaucoup à profiter. Une attaque de fievre l'ayant retenu ici quelques Semaines j'ai eu Souvent l'honneur de le voir, et par là l'occasion d'acquerir pour lui toute l'eStime et toute la consideration qui lui est duë. J'espere Monsieur que votre gros ver noir se Sera changé en Scarabé Mais c'est un tems bien dangereux pour eux que celui où ils se transforment en Nymphes.[162] *On a de la peine à faire changer les vers de quelques especes de Scarabés aquatiques lors qu'on les renferme dans des boëtes ou dans des pots. Ils aiment mieux être en plein air. Le changement de plusieurs m'a reussi lors que je les ai porté dans mon jardin Sur de la terre un peu labourée et couverte de foin ou de mouSSe. Je bordois l'espace où je les mettois, de quatre planches pour les empecher de s'echaper. Peut-être que les gros vers en question changeroient plus aisement. Si on en faisoit de même à leur égard.*

J'ai l'honneur d'être avec tout le respect et toute la consideration poSSibles

Monsieur

Votre très humble et très obeïssant Serviteur
LYONET

THE NATURAL HISTORY OF ANTS

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Although we may not always have occasion to praise the ants, we are as a rule well-disposed towards them — we have for them none of those aversions that are rather frequently entertained to so many other insects. One of the virtues most useful to a society is the love of labour; we love men who toil and we incline to love small animals that toil to a degree which we should like to see shown by all men. Everybody has had occasion to observe formicaries, has stopped to contemplate the activity, the ardour and the courage with which the diminutive population inhabiting them yields itself up to manifold labours, and everybody has admired the efforts of the ants when dragging burdens that seem so greatly to exceed their strength. Often after having observed an ant vainly exhausting herself in removing a bit of wood that, to her, must be an enormous beam, two or three others are seen to come to her assistance. On innumerable occasions they endeavour to help one another, to comfort one another. The burden which an ant has transported with too much fatigue to a certain point is often taken from her by another and carried closer to the formicary or even into the formicary. Long ago, moreover, the sage sent the sluggard to the ants for instruction, and that which they have so long been giving has not always been fruitless. Aldrovandi[1] would have us believe that we are indebted to the lessons of the ants for the publication of so many large and erudite tomes. He assures us that after admiring the ardour with which these small insects devote themselves to unceasing and painful toil, it seemed shameful to him to continue the life of ease into which he had allowed himself to drift, and that the example of the ants has had a similar influence on several great men. And he fails not to cite St. Jerome,[2] who relates that he determined to lead a more industrious life after

having contemplated with admiration the ants, of whose labours he has drawn an elegant and vivid picture.

But writers have not been content to admire what the ants permit us to see. They have sought to interpret to their advantage all their actions, even those whose motives are most obscure. We have elsewhere stated that unmerited eulogies have been lavished on their foresight. A government has been said to exist among them which ours might take as a model; they have been made to appear as civilized as ourselves. These authors, not content with assuring us that they have regular hours for work and others for repose, as they actually do have, pretend that like ourselves they have fixed days for work and holidays. Some have maintained that they refrain from work on the first day of every month, and Ælian[3] would have it that on that day they take not a step outside their abodes but remain within in perfect quiet. Others pretend that they have chosen the last day of each lunar month as their day of rest, while others, more profoundly erudite in their calendar, insist that they have chosen the ninth day of each month as a holiday. If we are to believe Pliny,[4] they have more than holidays: they have or they celebrate something like market-days. Since on their working days the ants disperse over the country and go far afield, each attending to her business without being bothered by what the others are doing, they would be living together without sufficiently knowing one another if, as Pliny imagines, they had not established a kind of market-days on which they can make and renew acquaintances. It is on these days, when they have nothing else to do, that they seek out one another, that they make a thousand and one efforts to find one another. According to the same author, the civility with which they then salute those whom they meet, the number of questions they ask one another, the politeness that pervades their intercourse, are beyond description.

Not only Pliny but all the ancient naturalists laud the ants because they honour their dead in the same manner as we honour our own. They assure us that each formicary

Portrait bust of Réaumur
advanced in years

has its cemetery.[5] It is believed, furthermore, that the dead ant is not carried thither till after it has been placed in a coffin; but that the living do not have to trouble to make one, because empty husks or follicles of certain seeds furnish coffins all but ready-made, among which they know how to choose the most suitable. Ælian tells us what decided Cleanthes to ascribe reason to animals, although he had always obstinately refused to do so. He was an eye-witness of what happened while the corpse of an ant — apparently not one of the common herd — was being borne away. Those carrying the body passed too near the entrance of another formicary, an act which is apparently contrary to the regulations among ants. The corpse was therefore seized by the members of the alien formicary. After several speeches, which the spectator failed to hear but the sense of which he could clearly divine, the corpse was released, but not till after the ants that were conducting the funeral had ransomed the corpse from those that had seized it by the payment of a piece of earthworm. If I report such stories it is surely not with the intention of either rendering them credible or of refuting them, but because they show us the progress of the human mind. What the erudite of former times seriously proclaimed to other savants would to-day scarcely be recounted by credulous nurses to their nurselings. But if one be curious for information in regard to what has been narrated to the glory of these small insects, let him read the sixteenth chapter of the *Theatre of Small Animals*, published by Moufet.[6] This chapter is nothing but a panegyric of the ants. The enumeration there made of their arts is a long one; they are ignorant of few that we practise in constructing buildings, except the employment of iron. All practise the same arts, but all do not practise the same art with equal proficiency. Each ant is destined to practise the one it knows best. The ant that knows best how to build arcades undertakes their construction; the one that knows best how to cut wood, does it; the one that has a talent only for burrowing in the earth, works only at that. Their kindness of heart leads them to lend charitable succour

to their sick, and, being adepts in medicine, they know how to apply suitable remedies. They have store-houses full of seeds of nearly all kinds, whence they choose the one that may be most salutary to the invalid they are treating and administer it to her, but only after having made it by special treatment an even better remedy than it was naturally. Nevertheless, they are less estimable in knowledge of the arts than in the moral virtues. Of the latter there is none which should not be ascribed to them, in the judgment of those who are enchanted by their modesty and especially by the modesty of their gait. What shall we think of their sense of shame, which requires that they yield only in darkness to the inclination to propagate their species, and never indulge in it on the days they have set aside for labour? They believe worthy of life only those who appreciate the value of employing time, and idleness among them is therefore punished by death. Their hatred of the cicadas and dormice is implacable, because the former pass the summer in singing, the latter the winter in sleep. In a word, the attempt has been made to convert the ants into little men, more perfect than the large ones to whom they have been proposed as models worthy of imitation. It is certainly permissible to regard the ants as small animals of even greater accomplishments if one have need of them in the composition of a pretty and instructive fable; but inasmuch as it seems to me that it is not permitted to naturalists to represent them otherwise than Nature has made them or rather such as we can observe them, the reader will find in the history we are about to present no facts so suited as those I have cited, perhaps at too great length, to do honour to the intelligence and good manners of these little creatures; but as compensation there will be found some singular facts of greater certainty, and among them several that have not been observed heretofore and are well worth observing.

The different species of ants exhibit few remarkable differences in form. When, therefore, the external appearance of one ant is known, that of all the other species is also fairly well understood. There are no forms that delight us

with the beauty and splendour of their colours as among the species of so many other insects.[7] Most species are chestnut brown, others are very black or bluish black; some are reddish and are called "red," others have precisely the colour of amber; but one never sees, or at least I have never seen, ants of a beautiful red, or of a beautiful blue, or of a beautiful yellow or of a beautiful green. There are white or almost white ants.[8] Some belonging to certain species have transverse bands across the body. They differ greatly in size, however. Yet the largest ants, at least the largest ants of Europe, are rather small insects. Ray[9] observed in England only five species. The descriptions he has made of them enable me to conclude that the same species occur also in France, where it is easy to find many more species. I have received from the islands of America, and from the Great Indies, several species that do not occur in this country.

It is by means of their habits and their different proclivities that it is often easier and always more agreeable to distinguish them from one another.[10] All are born for social life; there are in the group of ants, at least to my knowledge, no species whose individuals live a solitary life, as there are in the group of the bees and that of the wasps.[11] But the societies of ants of different species behave differently. Some of them, like civilized peoples, have fixed abodes; their formicaries are, in a sense, cities in enlarging which they daily labour. Ants of several other species have only temporary abodes and may be compared with the Tartars. They bivouac, so to speak, and are always ready to quit a spot where they have tarried as soon as it ceases to afford the conveniences that led them to select it.[12] A situation that seemed to them suitable at a time of drought ceases to be to their liking when the rain falls in abundance; they abandon it and, as soon as the weather clears again, leave the place in which they have taken refuge during the rainy days.

Among the formicaries of this country that are permanent habitations, the most frequently noticed on account of their

size and bulk and the number of their inhabitants are composed in great part of particles of dry wood, piled one on top of another. They are constructed by brown ants of the largest species in our region.[13] Most of these formicaries *are exposed to all the injurious effects of the atmosphere.* Some, however, may be placed at the foot of a great tree where they enjoy some shelter; others are in the heart of the woods; but, as a rule, they are found in exposed situations. Many of them are placed at the base of a hedge which can hardly provide them with anything but shelter from the north wind. Very often they are situated very near highways, but most of them are found along foot-paths or near hedges, where nothing protects them from the falling rain. But ants do not like to be wetted; hence their architecture though simple tends to prevent a too ready penetration of water as far as the bottom of their habitation, though it also tends to conserve a certain amount of moisture. We shall see in the sequel that while it is essential that the formicary shall not be inundated, it is no less essential that it shall not be too much dried by the sun's rays, although they may advantageously contribute to maintaining its heat. The ants have found that the best way of satisfying these various needs is to build up, one on top of another, little pieces of dead wood and divers other small bodies. On this they toil incessantly, so that the older a formicary becomes, the higher it rises above the surface of the ground. The greater portion of the edifice, however, is beneath the surface. The ants do not at first lay the foundations of the formicary so deep as later and concomitantly with rearing its upper portions. For a certain time at least they excavate the soil underneath; while they raise the superstructure they keep *sinking the foundations by burrowing to a greater depth.* We naturally inquire why this edifice beneath which they are continually burrowing does not cave in. To learn the reason it is only necessary to cut down through one side of a formicary, leaving the diameter of the highest greater than that of the lowermost portion [i.e., by undercutting]. The more elevated portion will maintain itself in the air

notwithstanding its projection. One may therefore infer that the various layers of woody particles form, as it were, arches capable of sustaining themselves independently. In a word, the formicary is an edifice in which the parts may be replaced bit by bit without greatly disturbing adjacent parts. There are some of these formicaries whose greatest horizontal diameter is more than three to four feet and which are but little less in height from their subterranean foundations to their summit. The complete demolition of one of these large and ancient formicaries fills one with astonishment at the quantity of materials that have been accumulated. Although the number of small insects that have co-operated in assembling them is obviously very great, and although they are known to be indefatigable workers, it is difficult, nevertheless, to conceive how they can suffice for such a task. Most of the particles are merely small fragments of wood, some thinner, some thicker, some longer and some shorter, but among them some are of such surprising dimensions and weights that one can scarcely imagine how they can have been transported by the ants to the places where they are found.

Among the particles of wood that make up most of the mass a great quantity of various kinds of small bodies may be noticed. Some of them are elongate, such as straws and divers pieces of dried grass; others, which are shorter and more rounded, are sometimes the seeds of various herbaceous plants or of various trees, such as those of beeches, lindens, elms, or the hulls of seeds; sometimes they are the pits of small fruits, such as those of wild cherries and medlars. Several of these small bodies are small flat pebbles. In a word, the ants regard as materials suitable for use in the construction of their lodgings, all small objects that are not too soluble in water, and they employ all those provided by the peculiar environment in which they happen to have established themselves. Close to a long avenue of horse-chestnuts I have seen some very large formicaries which were composed almost entirely of the leaf-petioles of these trees. These petioles are so long and, in fact, so thick compared

with the particles of wood of which the other formicaries are made, that if the former be regarded as small joists, the latter must be regarded as huge beams.

I shall prove, moreover, that the ants employ the materials they find at hand, by an observation which I made one year on the plain in the environs of Thouars, in Poitou. Along the borders of several fields I saw formicaries whose volume was inconsiderable, since some of them were not much larger than one's fist, while the largest were only twice or thrice as large. They were, moreover, inhabited by ants of moderate size.[14] All these formicaries were composed entirely of barley kernels. I have since passed the same spot several times and at the same season, without seeing any formicaries made of similar materials. Apparently, during a year when the barley was harvested too dry, many of the kernels had fallen on the ground, and nothing had seemed more suitable to the ants than to make use of them in constructing their habitation.

Nevertheless, the choice of materials is not a matter of such indifference to the ants of all species. There are some that build their formicary with bits of resin[15]; and if the resin is lacking they do not seem to be able to find a substitute in the particles of wood. What M. Scullens has said in his description published at Leipzig in 1720, concerning these formicaries built of resin, in the country about Jena, is worthy of mention in this place. He informs us that the ants that live in the pine forests collect the bits of resin exuding from these trees; that they carry them underground, where they make heaps of them which are sometimes concealed at a depth of more than four feet. Although the resin is buried in the form of small dry particles, heat has the same effect on them as cold has on pulverized ice that is thrown into a cooler: it fuses them into a mass. There is no difficulty in explaining how there may be at a depth of four feet underground sufficient heat to soften resin and render it somewhat plastic, especially when it is in a place inhabited by a great number of ants. The peasant women dig into the formicaries for the purpose of obtaining the masses of resin which they sell as incense, and

which is, in fact, called Thuringian incense (*thus Thuringorum*). The substance that is caused to evaporate from this material by the heat of the ants and the volatile substances added to it by transpiration from their bodies may account for the fact that it has a different constitution when extracted from the earth from what it had when first buried.

M. Elsholtius,[16] in the *Ephemerides of the Acad. Nat., Curios.* decennio 1°, anno 9, p. 229, also gives an account of resin found in the nests of ants that occur in great numbers in the forests of wild pine (pinastri) of the Mark of Brandenburg, and what he says of it leads one to believe that this resin has there undergone some advantageous alteration as regards both its odour and hardness. He reports that it is sold to the ignorant as myrrh or as amber. If it be sold, even to the ignorant, as something besides ordinary resin, it must be different. The kind under discussion is found only in the form of granules mixed with pieces of straw and wood. M. Elsholtius cites Kentmannus, who seems to have thought that the resin was converted into amber in the formicaries of the Mark of Brandenburg.[17]

Other ants with stationary abodes like to remain neither beneath the ground nor on its surface, but usually lodge in the interior of trees that are partly decayed. The very site they have chosen furnishes them with the materials with which they build so that they need not bring in materials from without. They gnaw the wood about to fall into decay and deal with it in a manner which will be explained in the sequel.

All the ants of Europe work on a small scale compared with certain species in the West Indies. If there be no exaggeration in the reports of travellers concerning their structures, they surpass those of other ants as greatly in their dimensions as the pyramids of Egypt surpass other ancient monuments. They are mounds of earth collected granule by granule and are as large as a hogshead. According to Oviedo, cited by Jonston,[18] p. 88, they are structures really comparable with the famous pyramids, when we compare them with the size of the individual ants.

We have in this country various species of ants that build only with earth, the granules of which are glued together; but they are very far from gluing enough of them together to form mounds that approach in volume those immense formicaries of the Indies. The largest barely equal the hillocks of earth which are the work of moles. In certain provinces of our Kingdom, for example in certain cantons of Maine, there is, neverrheless, reason ro complain of rheir size and still more of their number. They injure the meadows to such a degree as to induce those who let them to require among the conditions of rental the obligation to destroy the formicaries every year and to level the ground where they occur.

Nothing is more usual throughout the country than to see ants of several species of different sizes burrowing in the ground, carrying up on to some plant-tuft near the spot where they are digging all the granules of earth which they have excavated, and spreading them over the leaves and stems.[19]

Among those that carry only granules of earth there are some that are fond of concealing the nests which they build of them. During the months of May and June I have often seen such establishments of ants under the hollow support of almost any flower-pot. Others make their nests under boxes.

But other species of these insects live in the most compact soil. They excavate beneath the surface tortuous galleries that intersect one another and often penetrate to a depth of a foot or two. These subterranean passages are their dwellings; and they require none of more elaborate construction. The ants often enter them through three or four separate holes, which are the portals. Around the edges of these hole there are seen funnels made of the earth they have been obliged to bring to the surface in order to open up sufficiently spacious cavities.

Both those that keep themselves simply in hollow, tortuous galleries underground and those that build their formicaries entirely of heaped-up particles of earth have

habitations in which they find themselves comfortable as long as the weather is fair, but which they are obliged to abandon when the rains become abundant and continuous. In order not to be submerged they move out. Then they often find holes in walls where they have nothing to fear from drowning; they take refuge in them and establish themselves, going forth during the hours when no rain is falling to seek their sustenance in the fields. Finally, when the soil has dried out and they can look forward to a succession of fine days, they bethink themselves of establishing a new domicile more to their liking than the one they were thus constrained to occupy. They set about building again either by heaping up particles of earth or by excavating underground. Owing to the diligence with which they labour and the skill with which they excavate the soil, they acquire in less than a day a formicary in which they are protected from the rays of the sun, and which they subsequently enlarge and solidify.* From these quarters they retire as they retired from the first, when they are driven out by the rain. Thus during a year, and especially during a rainy year, they may be compelled to change their quarters many times and to construct in succession a rather large number of nests.

Ants of all species are more to be admired for the ardour with which they toil than for the artistry of their constructions. The architecture of every formicary is extremely simple and crude. After reading the descriptions made by the ancients of the interior of the several kinds of habitations, one might be prepared to find them divided up like some of our large buildings. They distinguish among them several apartments set aside for different purposes.[20] According to these authors, the first and most spacious is the lodging of the ant population; the second is, so to speak, the apartment of the women, the gynæceum, where the females abide with their small families. They have placed the granaries at the portals of this noble apartment. Finally, some have placed the cemetery immediately next to the

* Exp. To force these ants to make their formicaries.

granaries. The only truth in all this diversity, in which nearly everything about the granaries and the cemetery is to be rejected, is that usually most of the ants are found nearer the top of the formicary than are the young insects which constitute their ardent hopes and which are not yet ants. And we should be forming a wrong idea to imagine large squares like those of our cities, or anything like halls, immense in comparison with the whole edifice, for the general assemblage of the ants. If, in order to form a juster conception, we compare the formicaries with cities proportional to the stature and number of the citizens, it would be with cities composed only of arcaded streets; or if we be content to compare the formicaries with a single edifice built for the accommodation of a great number of tenants, they may be said to be composed throughout of intersecting stairways, while the most roomy spaces of each formicary are very small and comparable with the landings of the stairways. It is therefore in the streets, which are really covered over, and on the stairways and their landings, that the ants abide, now higher and now lower, according to the conditions of the atmosphere. So many intersecting galleries seemed to Ælian[21] worthy of comparison with the passages of the famous labyrinths, but the passages have not been multiplied in the formicaries for the sake of puzzling the ants; they have been constructed to enable them, no matter where they may be, to find one that leads up or down and one that leads to the right or to the left and others that lead in all the other directions.

We might suspect, nevertheless, that within the formicaries, and especially within those made of such a prodigious number of small particles of wood, there could be some peculiar arrangements hidden from our sight. But let us destroy the arrangement of these woody particles and while doing so examine all that seems worthy of observation from the upper surface to the foundations of the formicary. For the purpose of examining a formicary from top to bottom and as far into the interior as one may hope to see, and perhaps as far as one need see, I compelled the ants to

construct their nest under my eyes in a transparent vessel. After having fitted a cover of thick cardboard to one of the largest glass bell-jars with which bedded plants are covered, I threw into it the ants which I took in handfuls from a very populous formicary at a time when they were rather inactive. Besides the ants, I placed in the bell-jar a portion of the materials which they had brought together. After the bell-jar had thus been filled to more than two-thirds its capacity, I applied the cover so that the ants were imprisoned. The number confined greatly exceeded the number that had escaped me. As would be expected, they at first sought to escape from a place in which they were confined against their will, but being unable to find any egress they seemed to become reconciled to their captivity after the expiration of some hours. Then some of them began to move the particles of wood, endeavoured to rearrange them more suitably and finally during the following days gave themselves up in earnest to this labour. As it was not my intention to allow them to perish of fatigue and hunger I failed not to provide them abundantly with the kind of food I knew to be most to their liking. I had made a door in the cover through which I passed such food as I wished to give them. Finally, I did all in my power to prevent them from regretting anything but their liberty. They did not therefore seem to feel uncomfortable in their prison. In addition to the particles of wood which they had at first at their disposal I subsequently gave them others. I let them lack for building materials no more than for food, so that they built a formicary externally similar to the one they had formerly occupied and apparently no less similar internally. It exhibited only tortuous galleries, some of the larger of which might be compared with our wide and most frequented boulevards, while the others were narrow and could be compared only with our narrow streets.

By means of a similar expedient I have also compelled ants of some of the species that remain below ground to work under observation. I confined all those of the same society in a very large vessel of white and very transparent

glass made in the form of a flask and almost filled with friable earth. After some days it was quite filled with the same quantity of earth, because the ants that were burrowing within the mass carried the excavated particles of earth one by one to its upper surface. All the earth, which was very compact because I had pressed it down, was rendered much looser than that which the gardeners have passed through screens of the finest mesh. Galleries extending in divers directions, but all leading to the bottom of the vessel, seemed to be the only feature of the interior that was worthy of notice. Some of them were next to the very walls of the vessel, though none descended in a straight line.

The formicaries that seem to be constructed with the greatest art are those made of compact earth and those made of the sawdust of nearly decayed wood.[22] Both are composed of a great number of plates or interconnected laminæ built in such a manner as to enclose cavities arranged in storeys, though rather irregularly. The total mass resembles nothing so much as a sponge, but has larger cavities than sponges of the coarsest variety. None of these cavities ends blindly, but all of them communicate with one another. They are of very unequal dimensions in the same formicary. Sometimes the ants may enter one of the largest cavities through five or six of the smallest and leave it to descend to a lower level through as many other small cavities. The formicaries in the construction of which sawdust is employed sometimes form rather considerable masses which may assume the consistency of wood that has been perforated in all directions and, as it were, converted into a sieve by the ants. Such masses may be taken, and I have seen them actually taken by physicists, for solid wood; indeed nothing so closely resembles solid wood as a paste made of granules of partially decayed wood. The ants moisten the particles which they detach with a liquid that glues them together.[23] They then apply the small mass thus formed of agglutinated granules to the larger masses.

These latter formicaries require concealment. They are usually found in the trunks of trees whose heart wood is

rotten. Sometimes they are seen at the bases of trees under their roots. It is essential that the ants that build them shall have in their environment wood that is more easily reduced to dust than that which is sound. The kind of wood seems to be of much less importance to them. In the forests they make their establishments in the oaks, and in my garden I have seen some that made theirs in hollow horse-chestnut trees. I have even been able to observe some of these ants while in the act of enlarging their formicary. They lay their foundations at the bottom or very near the bottom of the cavity and build up the structure day by day, a very slow process. Sometimes in two or three weeks they increase the height by only one or two inches. The upper surface of the formicary which I was able to observe was always covered with a layer of powder, or wood-dust, at least five or six lines in thickness, the particles of which did not at all cohere. This layer is the mass of material that is destined to be worked over. While some of the ants take the particles from the lower surface in order to make a paste with which to form successively the various small beams that enter into the composition of the formicary, others busy themselves with transporting granules and depositing them on the upper surface in order that there may be no dearth of materials.

The glass hives[24] in which I keep the bees have provided me with a better opportunity of seeing the interior of the formicaries made some with wood paste and some of a paste of earth, an opportunity which I could scarcely have hoped for if I had had to devise means of securing it. Every year ants of various species endeavour to profit by the warmth which the bees maintain in their habitation. The glass panes of these hives are covered by shutters which are opened only when I desire to see what the bees do within the hive. Between these shutters and the panes there is from top to bottom a space of often more than an inch. The ants feel that they can do no better than profit by a cavity in which they can constantly enjoy a pleasant warmth.* I have often

* What happens to the ants of the hives in winter? It would seem that they could not find better quarters, but nevertheless they do not remain in them.

found in these interstices extremely populous colonies, some of which were content to bring in and heap up particles of earth, while others worked up a paste of either earth or wood. And I have seen one of these very populous societies, comprising ants of all ages, behind the shutters of hives in which I had established bees only two days previously. The knowledge of these insects, if they possess knowledge, does not extend to knowing that the shutters and the panes so conveniently arranged have not been placed there for their benefit. They fail to foresee that their abodes cannot be of long duration; that all will be destroyed by the first curious person who opens the shutters. Still less can they foresee that a person like myself will appear, who, while regretting to annoy them, will allow them to remain undisturbed only on the condition that he may be permitted to observe them from time to time. I attached a pane of glass outside the hive at a level with the inner surface of the closed shutter. Thus the nest was enclosed between two panes and, being no longer supported against the shutter, it was possible to open the latter without in any way destroying the work of the ants. Through a very transparent pane it was easy to observe what they were doing. Nothing could be concealed in the interior of a nest so thin and full of cavities arranged in storeys: its whole thickness was visible from top to bottom.[25]

Instead of using wood paste for making lodgings that resemble sponges, like the ants of which we have been speaking, others build very similar structures by perforating pieces of soft wood. And just as there are ants that content themselves with digging intersecting galleries in the earth, so there are others that tunnel their galleries through half-rotten wood; for example, I have had old garden benches in which the ants had established themselves in great numbers.

The late M. Raoul, councillor of the Parliament of Bordeaux, who was competent to make observations and willingly communicated those he had made, entertained me in one of his letters with an account of white ants[26] of the size of our commonest species, but which I have not had

occasion to see. He saw them in prodigious numbers at the end of the May following the winter of 1709. That winter, which caused such losses to a great part of Europe, killed the pines in the *landes* of Bordeaux. M. Raoul had to have more than 2000 of them felled because they had been killed. A spirit of curiosity prompted him to strip the bark off a few, and later off a large number, because he found in all of them between the bark and the wood thousands of white ants living in a kind of powder almost as fine as Spanish tobacco [snuff]. He could find none of these ants under the bark of various other trees that had perished as a result of the severe cold of the same winter.

There are species of ants to whom the flower-head of a teasel is what a great tree is to others. M. Bonnet[27] found some very small red ants that had made their nest in such a flower-head and so gave him the pleasure of observing them with his own eyes in his laboratory. After cutting off the stem of the teasel, leaving seven or eight inches of the portion to which the head was attached, he stuck the lower end of this portion of the stem into some earth with which he had filled a glass. He placed this glass or, what is the same thing, this formicary in his laboratory, where it remained for nearly a month with its diminutive people, because he had been careful to satisfy all their requirements.

After having formed an adequate notion of the diversity that may be exhibited by the habitations of ants of different species, we must endeavour to ascertain how these habitations serve them, what they do within them, with what intentions they leave them to run about in the fields and how they perpetuate themselves. Finally, we must ascertain how each ant passes its always very busy life, for they never cease from their activities, except at times when repose becomes a necessity. They are therefore worthy of all the eulogies that have been lavished upon them so far as their love of work is concerned; but, as we have already said several years ago, they have also been lauded for a foresight they do not possess, because it would be useless. It has always been believed that nothing so occupies them during the summer as their solici-

tude in making stores of grain which are to be used as food during the winter. They have been cited as calculated to overwhelm with confusion those of us who are insufficiently alarmed about the future. Still the charming fable of the ant and the cicada is none the less instructive, though it is certain that the ant knows nothing about storing provisions during the summer and though every year all the cicadas die long before the advent of winter.[28]

I should not have undertaken to depreciate the ants or to deprive them of the glory they have peacefully possessed since time immemorial, had I not been compelled to do so by proof which is not to be gainsaid.[29] I was curious to behold those well-filled store-houses which have been so much extolled, and in order to discover them I have dug up at different seasons of the year a great number of formicaries. The excavations were carried much deeper than the greatest depths at which the ants occur, even to depths where there seemed to be no traces of a gallery. These excavations were also extended to the immediate neighbourhood of the formicary, but always in vain. Never did I succeed in discovering the place where they store all the seeds on which they are supposed to subsist during the winter. And I know several persons who, curious like myself to find these subterranean granaries, have searched for them in vain.

We can scarcely suppose that accumulations so considerable as those reputed to be necessary to the ants could have eluded so much searching. Besides, I have not failed to study the ants during seasons when they should be most occupied in carrying in the seeds. Whatever cleverness they may have employed in concealing the operation, it is impossible that I should not have succeeded in detecting the place where the seeds were deposited. But the purposes for which they are supposed to make these putative stores would not permit them to deposit the seeds in any other place than in the formicary itself. It is assumed that they are provisions essential to keeping the ants alive during the winter. Now while the cold endures they remain confined and under cover near the bottom of their habitation and do not leave it. If

at that time they must have granaries of wheat these must be near the ants. It is, in fact, within the formicaries that authors have placed the granaries which I have sought in vain. In many formicarics which I have uncovered in the winter time and to the bottom of which I have dug, I have never found either sound seeds or the remains of seeds that had been eaten.

But, finally, all the cleverness the ants might be supposed to employ in concealing their granaries would have been of no avail to those that I kept in the large glass bell-jars. I have already stated that I neglected nothing that might minister to their comfort, and that they built with the particles of wood and the other small bodies placed at their disposal a formicary similar to the one they had previously occupied and like those constructed in the open country. In this case they did everything that ants know how to do. They had every opportunity to procure with little labour granaries full of seeds. At various seasons of the year, in spring, in summer, in autumn, I threw kernels of wheat in good condition on their formicary. They had only to collect them, and the distance they had to go for this purpose was not great, whether they wished to pile them up on the formicary or in the earth that formed its foundation. But they left them for the most part where I had cast them and moved only the kernels that encumbered their galleries. They did not carry them into the interior of their habitation.

Authors have not been content to assure us that they lay by kernels of wheat, but have also pretended that they possess the secret of preventing the seeds, though deposited in a moist place, from running the risk of spoiling. In order that they may not germinate, they are said to cut out the germ of each.[30] The ants in my bell-jar did not even practise the art of storing the grain that was placed at their disposal. Hence it did not long remain without germinating; eventually it even put forth blades just as it would have done had it been sown in good earth.

If the ants had need of a knowledge of making granaries and of preserving the seeds stored in them, they would no

doubt possess and exhibit it; but this knowledge would be as useless to them as it is to the insects of so many other groups that pass the whole winter without taking any food. When the cold becomes sufficiently intense to prevent the ants from running about in the fields, they remain quietly in the quarters they have prepared for themselves and there they lie piled up one on top of another without showing any movement. I have always found them in this condition at the bottom of their formicaries whenever I have opened them during the winter. But when with the fine days the rays of the bright sun warm even the interior of the formicary, they revive, leave the nest and undertake excursions that are more remunerative than those made by the bees at so early a season. The latter must have on hand a provision of honey while they are vainly seeking for the flowers from which they might extract it, but at all seasons the countryside provides the ants with a variety of viands to their liking.

It is strange, nevertheless, that the kernels of wheat which they have been said to store are precisely one of the earth's products on which they do not subsist. Probably a kernel of wheat has never been gnawed by an ant. They left sound and entire those that I cast on the formicaries confined in the bell-jars. Let it not be supposed, however, that if they failed to touch them it was because I provided them abundantly with foods that they found more acceptable. I performed an experiment that proved to me that the direst need could not compel them to live on wheat. I enclosed in a beaker[31] some ants from a formicary made of little sticks and gave them some morsels which I knew they liked but without giving them the wherewithal to construct a lodging. In another beaker I placed about the same number of ants from the same formicary and taken at the same time, and I offered them nothing as nourishment but a lot of kernels of wheat. In a few days all the ants in the second beaker had perished, and it is more than probable that this was on account of hunger, for all the grains were found to be perfectly intact. Not one of them seemed to have been touched by the mandibles of the ants. The ants of the first

beaker, which was always kept beside the second, were at that time very lively and lived several days longer, although they had no nest, and perhaps it would have been possible greatly to prolong their life had I wished to care for them further.

On what grounds, therefore, are we assured that ants make granaries and that they do not fail to cut out the germ of the seeds which they harvest? It is because they have actually been seen to transport kernels of wheat and because these kernels were seen to remain on their formicaries and there failed to germinate. More has been inferred from these facts than should have been inferred. It has been believed that the ant that carries a kernel of wheat sets herself a purpose different from that which she has when she carries a particle of wood or a small pebble or a crumb of earth. All of these, nevertheless, are destined to enter into the construction of the formicary. Several similar seeds may be thus employed, for we have previously reported that we have seen small formicaries whose only materials were kernels of barley, some of them heavy — that is, in good condition — and others very light. I dug into the earth which was covered with these grains and into which the ants had penetrated, but they had not buried a single seed. They were, nevertheless, in possession of a sufficient number to fill large granaries. If it frequently happens that the wheat kernels that they carry home fail to germinate, this is because they choose the very lightest ones and consequently those in the worst condition, with their inner parts decomposed and therefore incapable of germination even when placed in good soil. All those they transport are not, however, so bad; they carry heavy if they fail to find light seeds. Thus, at the end of September or in October, I have more than once seen wheat growing and already rather high around a formicary situated near a field in which there had been a plentiful harvest during the month of August.

In general seeds which contain only a farinaceous substance, dry and insipid, are not to the liking of ants. They paid no more attention to the kernels of barley, rye or oats

which I offered them than to those of wheat; they also rejected the seeds of lettuce, chicory and other plants. Like ourselves they are fond of juicy fruits and especially of those containing sweet juices. It is unnecessary to call attention to their great predilection for sugar and sweet liquids. How very difficult it is to keep them away from confectionery and preserves, especially in the country, is well known. When a single ant has been fortunate enough to discover the pantry in which such provisions are kept or has penetrated into the cupboard in which they are locked, she apparently loses no time in informing her companions of the fact. Then there is seen from morning till night a dense, continuous file of ants going forth to pillage. They are not disconcerted by the length of the journey they may be compelled to make. No matter how far the pantry may be from the garden and therefore from their formicary, they nevertheless visit it in order to gorge themselves with the fruits that have absorbed more sugar than those provided for them by Nature. They crawl up to the first or second or even to the third storey and, if need be, even higher. No matter what one tries, one has no success in diverting them, and no matter how great a number one may kill, the number of the living, uninformed of the sad fate of their predecessors, is not seen to be perceptibly diminished. Then the preserves and confectionery can be rescued only by taking them to a different spot or consigning them to almost hermetically sealed cupboards, or, finally, by devising some arrangement whereby, in order to reach each pot or preserve jar, the ants must cross a great pool. This is done by setting every jar in a saucer or plate full of water.

But not all species of ants have so decided and so keen a taste for sugar. The largest ones of this country, those that build with particles of wood, do not come to pillage our preserves. Moreover, they paid little attention to the pieces of sugar that I cast on their formicaries. When the pieces disappeared after several days, it was because they had melted and not because they had been eaten.

A motive similar to that which leads the ants of different

species, either of very small or moderately large size, to enter our houses, induces them to climb to the tops of the highest trees.[32] Along the trunk of the tallest oaks rather broad, uninterrupted files are often seen, some composed almost entirely of ascending and others of descending ants. These files are sometimes continuous from the foot of the tree to the tips of its smallest branches. In the country there is no species of tree on some examples of which ants are not seen to be passing thus as in a procession. Such processions are also seen on plants of all species, and in like manner they are seen on the plants and trees of our gardens. The gardeners are convinced that they seriously injure the trees, especially the peaches and apricots, on which they may be seen in great numbers. Also those who cultivate oranges resort to many devices to prevent them from climbing the trees to which they have taken a liking. The expedient that best succeeds is the same as the one employed to keep preserves from the inroads of ants. When the box in which the orange-tree is planted is supported on feet, either in the form of balls or otherwise, each foot is placed in a vessel full of water.

But the ants often know how to circumvent the precautions that are taken against them. An eye-witness as much respected as beloved by all Europe, and for the lengthening of whose days all nations unite their prayers with those of the French, who fear nothing so much as the end of the kindest and wisest of ministers ever named in their annals, the Cardinal de Fleury,[33] after telling me that he had always been a great admirer of the ants, related that he had observed some of them constructing a bridge over the water of a vessel in which a leg of an orange-tree box had been placed; that while he was looking on they brought small particles of dry grass and small particles of wood and arranged them side by side from the edge of the vessel to the leg in order that they might cross dry-shod. He assured me that he had also seen certain ants resort to a very similar expedient on another occasion. In order to stop them by making their path impassable, a band of glue had been put

around the trunk of a tree. But they set to work to build a highway and to repair the interruption by bringing and placing side by side particles of earth, grains of sand and even small pebbles, after which they found it possible to surmount the obstruction.

Books on gardening give us a secret method to prevent ants from climbing a tree: the encircling of the trunk with a simple band of chalk. It is true that the first ants to attempt to cross this band topple over. The particles which they seize with their claws are not sufficiently adherent to support their weight, and they fall to the ground, but the fall is not fatal to such light insects. There are so many of them desirous of passing and the same ant endeavours to pass so frequently that all the removable particles are carried away and what is left of the chalk remains firm and no longer arrests their progress.

After all, even if there were means of preventing them from climbing the trees that they frequent in such numbers, it would be inexpedient to resort to them. If the trees they visit seem sometimes to suffer, the ants should not be blamed. They in no wise seek to injure the vegetation, but they know that there are on the trees certain species of insects besides themselves that work for them. Whenever we follow the ants to a spot where they stop, we discover plant-lice or scale-insects either on the leaves or on the branches. I have stated elsewhere that I have had no better guides than the ants in discovering new species of both these insects.[34] The plant-lice emit from their posterior end and through two tubes near it a sugary liquid for which the ants are very greedy. A similar liquid exudes, perhaps, from divers parts of the body of the scale-insects, and the ants like to lap it up. In brief, both the plant-lice and the scale-insects produce an effusion of liquid by which the ants profit. This is demonstrated by the study which we have published on the plant-lice in the third volume and on the scale-insects at the beginning of the fourth volume.

Nevertheless, I would not minimize the harm which I know to be done by the ants. A species of moderate size,

very dark brown and very shining, greatly injured under my very eyes the flowers of an apricot-tree that was among the earliest to bloom. When I noticed that the ants were very numerous on this tree I could not at first believe that they had evil intentions, but supposed that they had been drawn thither by scale-insects or plant-lice. My gardener, however, showed me that they were attacking the flowers. They cut off the pistil of the fruit and often the fruit itself when it was about to swell. This species and perhaps several others may therefore do considerable damage to the flowering trees which they visit. They are also accused of gnawing the tender buds.

To one examining the ants that in very dense files ascend and descend the trunk of a tree, they seem all to belong to the same species and to all appearances to the same colony. It would seem that the plant-lice and scale-insects that have been discovered on a tree are the property of the formicary by which they were discovered. At least they remain in the peaceful possession of the colony that first finds them. Alien ants happening by one by one are too feeble to encroach on the army already in possession, and this army always resists an attempt on the part of strangers to participate in the harvest of the sugary liquids emitted by the plant-lice and scale-insects.

Still there are occasions when ants of different species contend in combat for the possession of a tree. Such a battle, perhaps the most memorable on record, has been reported and pleasantly described by Æneas Silvius,[35] who was afterwards pope under the name of Pius II. His account of the battle has been repeated by most of the historians of ants. It occurred in the environs of Bologna, and an old pear-tree was the battle-field as well as the occasion of the conflict. Some small ants had found their sustenance on it, but larger ants undertook to drive them away, killing some of them and compelling more to flee. The latter, arrived at their formicary, informed their comrades of the bad and unjust treatment they had received and demanded their aid in securing revenge. Two hours later an army left the formicary,

and the numbers of the combatants soon covered the earth in the neighbourhood of the pear-tree till it was black with them. The small ants courageously climbed the tree, where the larger ones were intrepidly awaiting them. The first shocks were severe, the usurpers being superior in strength and the others in numbers. There were more than twenty of the latter to one of the former. Nevertheless, the small ones suffered greatly in the first attacks and so many were killed that a heap of dead bodies fell to the foot of the tree; but eventually the small ants carried the day and remained mistresses of the pear-tree. Less deadly battles frequently take place between ants of different species or merely between different colonies of the same species, when one party desires to retain possession of a tree and the other desires to be free to forage on it.*

Ants so commonly have a taste for sugar that we are not surprised to learn that there is in Cayenne a very large and prolific species which causes great damage in the sugar-cane plantations. In Martinique there is the same or a very similar species, against which similar complaints have been made.[37]

It was very essential that bees should be armed as they are, for otherwise it would be impossible for them to keep the honey which they store. The ants that establish themselves even between the glass panes and the shutters of an observation hive do not dare make incursions into its interior as long as it is well peopled with vigorous bees. They become bolder when they discover hives whose bees are languishing and about to perish through dearth of provisions, and then undertake to rob them of their remaining supplies. They covet even smaller quantities of honey than those left in the hives. We have noticed in the preceding volume[38] that many species of solitary bees bring to each of the cells in which they are to deposit an egg a quantity of honey-paste sufficient to nourish the larva that hatches from each egg till it is far enough advanced to become a bee. When one of these cells is discovered by ants before its com-

* See the *Mémoires* of the Academy. Questions of M. Arture.[39]

pletion, the single bee is unable to defend the honey she has collected against the host of ants that come to rob her of it. She has no other resource than to abandon it to them.

The juices obtainable by the ants from vegetable substances are not the only ones they crave. They are also carnivorous, but they are not cruelly so. Although they are armed with two large, powerful mandibles, they are not seen to attack even insects that are very inferior to them in strength and less heavily armoured. They stalk about over thousands of plant-lice, which are incapable of defending themselves and over thousands of scale-insects as little able to offer resistance, without harming them, but when they encounter in their path the carcass of any small creature they at once begin to imbibe its juices. They are often seen transporting small flies to their formicaries; but they gather about dead insects that are too heavy to be removed. If one gives heed to the beetles that die in the garden paths and especially to those that have been crushed, to the dead caterpillars and grasshoppers and, finally, to the cadavers of insects of nearly all species, they will usually be found, if not too dry and hard, to be surrounded by a number of ants.

Some who have studied the tastes of ants, with the intention of destroying them, and have noticed that they congregate about dead earthworms, believe that the best means of exterminating ants in gardens is to expose chopped earthworms in a flat dish. This is a bait that will assemble the ants by thousands and thus provide an opportunity to kill them in great numbers. Honey is said to attract them less than these pieces of earthworm. This device, moreover, comes from a reliable source. It was published in the French translation of the *Gardener's Kalender* of M. Bradley.[39] The man to whom we owe this receipt had no ambition to appear as an author, but wished only to be useful and cared little whether others knew that he was so.

But although the ants do not wage a determined warfare on other insects, there are occasions on which they may kill them. If, while wandering about, a caterpillar imprudently passes a formicary, it must be very large and very formidable

if it is to proceed safe and sound. It is soon attacked from all sides by the ants, each endeavouring to inflict a bite with her mandibles. I have sometimes purposely cast moderately large caterpillars on a formicary and seen them killed on the spot. Even at a distance from their abodes ants are sometimes seen to attack living insects. I have seen some of them attacking plant-lice, but it has always seemed to me that the insects with which they were occupied must have been previously wounded. It is not, perhaps, that they believe they have more right to these than to others, but the juices and the flesh that exude from the wound whet their appetite, and then, too, they perceive that wounded prey is more easily overcome. When I gave them insects that I had injured, they attacked them, but permitted the sound ones that I placed just outside the formicaries to escape. Perhaps, however, I have made a too sweeping generalization in regard to the ants being carnivorous without being cruel, because one observation seems to me to prove that there is at least one species that actually hunts certain small caterpillars. One spring, on lifting a large flower-pot under the base of which ants had constructed a rather extensive abode of earth, I found the whole upper surface of the nest covered with rare little caterpillars which were just then common. The caterpillars in question prefer elms, on which they live while the seeds are still green.[40] Though small, they are easy to find, because they enjoy letting themselves drop at one end of a thread that is fastened by the other end to a branch of the tree. One would have to be too favourably inclined towards the ants to believe that those under discussion had carried into their nest only such small elm-caterpillars as they had found dead or dying.

Other flesh than that of insects may be very acceptable to ants. I have often given those I kept confined in the bell-jars raw pieces of the same meats that we eat cooked, and found that they used them as food.

It is also known that in order to obtain skeletons of small animals more perfect than any that can be made by the most expert anatomists it is only necessary to bury the

dead animal in a formicary. In this manner beautiful skeletons of mice, small birds and reptiles may be obtained. The mandibles of the ants are skilful in removing the bits of flesh and tendons which the finest scalpel fails to reach. Sometimes, however, the mandibles cut away more than is desirable.

They are greedy for insect eggs, which are covered only with a membrane easy to perforate. Several species of spiders lay their eggs side by side on the folded leaf of a tree or plant.[41] The batch is covered only with a web of white silk on which the impressions of the ends of the eggs are visible. The spider plants herself near and often over this mass of eggs, apparently for the purpose of incubating them. There is another reason for her not abandoning them: if she failed to guard them continuously they would be devoured by the ants. I have had more than one proof of this, and repeatedly I have taken, after driving the spider away, the batch of eggs with the leaf and placed it on the ground or on a bench in the garden. And more than once after some hours I have found the ants engaged in detaching and opening the eggs — in a word, devouring them. They left not one of them intact.

I have reason to believe that the soil itself may serve as food for the ants that make subterranean habitations.[42] I placed some of these ants in a beaker partially filled with good, ordinary earth in which no filaments of roots could be detected, and I gave them nothing besides. They nevertheless worked at moving the earth and mining into it and were often compelled to repair their structures, which I took delight in destroying from time to time. Notwithstanding all their efforts, which it is improbable they could have continued without nourishment, several of them lived more than a year in the beaker, in which there was nothing either to eat or imbibe except earth.

Ants are generally so well known that up to this point we have been able to speak of them without danger of being misunderstood, although we have as yet said nothing about their external form. It is now time, however, to call atten-

tion to the essential peculiarities of their form, to the more constant features of which it is composed and to the variations they present. The head is considerably thinner than it is broad or long. Its outline is nearly triangular but its anterior angle is somewhat truncated, though at certain times it does not appear to be so, the apex being supplied by the tips of the two mandibles when they are applied one to the other. The upper surface is not flattened. It is divided into two equal portions longitudinally by a shallow furrow. Each of these portions is somewhat convex, and very near their anterior end there arises on each side an antenna composed of a series of joints. On each side also, but much nearer the posterior than the anterior end, is placed a faceted eye of sufficient size to be visible when sought, though it has neither the volume nor the brilliancy of the eyes of butterflies and most flies. Three other eyes, much less clearly visible, smooth and arranged in a triangle, are found between the lateral eyes in the longitudinal furrow. Cardano, however, alleges that ants are blind, and Aldrovandi, surmising that they must see, and agreeing with Cardano, that they could not have eyes on so small a head, is inclined to believe with Albert the Great that they have eyes at the tips of their antennæ.[43] The head is movable in all directions by means of a neck which unites it to the thorax. The latter is very long in most ants, often longer than the abdomen. It is narrower from side to side than from top to bottom; above, it is somewhat gibbous and rugose. To it the six legs are attached. Behind the last pair of these the thorax becomes very slender. In some ants it terminates in a series of two or three nodes which seem to be so many segments. Among them there is at least one articulation, and this is necessary in order to allow of the various movements which the ants make with the abdomen. They can bend it forward under the thorax towards the head. Sometimes they make a chair of it, on which the thorax is seated upright. They then assume a very comical posture, in which their posterior legs assist in steadying them while they hold their anterior legs aloft. When they gesticulate with the latter they seem to be preaching.

Their abdomen has only five rings and would have much the form of a truncated cone except for the rounded contour which it presents at the point where it joins the thorax. It is united to the latter merely by a filament as delicate as that which holds the thorax and abdomen of an ichneumon fly together.

The ants, among which winged individuals are found at certain seasons, are also true flies[44] of the class of those with four wings and should have been placed in the present work immediately after the ichneumons, had not other considerations prevented me from assigning them the position required by the parts that characterize them in all the species I have observed. The ants that have wings carry them in the same manner; all hold them parallel to the plane on which they rest and somewhat overlapping one another. The two superior wings are the only ones that are visible, and they conceal the inferior, which they surpass considerably in amplitude. The former have at least double the area of the latter.

We have already noticed another group of flies, that of the plant-lice, among which in each species there are winged individuals and others without wings. We have also seen that in some species of moths the females are wingless, whereas the males have large and beautiful wings.

Among the ants the winged individuals are likewise the males; it is natural to think so, and Swammerdam believed it to be true.[45] At certain seasons in the majority of formicaries very large winged individuals, contrasting with the bulk of wingless individuals, may be observed. Moreover, at such times smaller individuals, which are also winged, may be detected. I know not by what chance it happened that these escaped the scrutiny of the attentive observer we have just mentioned, though he did not fail to observe certain wingless ants whose abdomen equalled or surpassed in volume that of the largest winged individuals. He thought that the large winged ants were the males, that they were to the formicaries what the drones are to the hives of bees, that the large wingless ants were the females and, finally, that all the other ants were sexless, that they were charged

with all the work of the formicary as is the case with the majority of bees and that therefore they could be rightly designated by the name of "workers."[46] Dissection confirmed him in the notion which analogy and the volume of the abdomen had suggested to him in regard to the large wingless ants. It showed him that their abdomens were full of eggs. If even without troubling to open the abdomen one merely compresses it tightly there will be seen to extrude from the anus or from some point where the abdomen bursts, a soft white mass which, when examined under a strong lens, seems merely to be a collection of round granules that can be taken for nothing but eggs.

But Swammerdam's inference in regard to the large winged ants, when he makes them out to be males, apparently because he is unable to make anything else of them, this conclusion, I say, is not so certain. If in order to ascertain their sex he had only resorted to dissection, or simply to strong pressure, he would have forced out of their bodies eggs, sometimes precisely similar to those which he extracted from the abdomens of the large wingless ants, but sometimes less distinct or smaller. In a word, he would have convinced himself that the large winged ants are themselves females.

Are there then in a formicary two kinds of females, winged and wingless? No, there is only one kind; both of them are the same individuals seen at different seasons. There constantly happens to the winged ants what happens to no other known animal of the class of those that bear wings: they lose theirs. A bird that should shed its wings would seem to us to be in a pitiable state; the ant which has four and at a certain season is glad to have them, at another season is better satisfied to possess them no longer. If we compare, therefore, a large wingless ant with a large winged ant, almost no differences, apart from the wings, can be detected between them, although Swammerdam believed that he could perceive other differences. The most real of those that he cites is a difference in colour, which reduces itself to a paler hue in the one than in the other.

But it is usual to observe such variations in the same animal when examined at different ages.[47]

The ancient naturalists, instead of telling us of the interesting fact in the history of ants that there comes a time when the winged individuals lose their wings, have unanimously maintained the very contrary. They have assured us that, having had no wings in their youth and at the time of their full vigour, they acquire them during their old age; that the wings sprout forth when the insects become decrepit and are about to die. One would have little ground to deny a statement so generally made if one could oppose to it only the apparent improbability that wings were given to ants merely in order that they might perish with greater dignity, or, as Cardano would have it, as a consolation in their old age.[48] It does seem improbable that they would be bestowed on ants that are no longer in a condition to function for the good of their species. And in this case, what apparently should not be, is not. When we follow the ants through their various stages we see that those that are born without wings pass their lives without having them, whereas those that are to be winged have wings from the moment of their birth, like the other flies and the butterflies; that is, after the transformation which enables us to recognize them as ants.

After observing in a formicary nothing but wingless ants, and then after a certain time the occurrence of winged individuals, authors too hastily inferred that the ants that had wings were of the number that had formerly lacked them. There is no danger of drawing a similarly false conclusion from the observations that go to prove that the ants naturally lose their wings. But before describing the manner of making these observations, which is as easy as it is simple, it will be well to recount the circumstances that are most favourable to making them. And in order to understand these we must ascertain how the females are fecundated.

Now if we observe a formicary at certain seasons we find in it certain very large ants which we might regard as having lost their wings, and which are actually such individuals. We find also others quite as large that still possess wings.

Both kinds are females, though their number is always far inferior to that of the wingless ants of medium size, which are the ones that carry on most of the work.* We also find some very small wingless females and finally some winged individuals as small as the latter.† If the female ants have need of males — for this is a question we may ask, since we know that plant-lice are fecund without copulation[49] — it is natural to suspect that the small winged ants are the males. The great disproportion in size by no means conflicts with this presumption, since the general rule among insects requires that the males should be smaller than the females. No matter how small a male may be compared with its female, we refuse to be surprised after our acquaintance with the males of the scale-insects. I am astonished that Swammerdam did not chance upon these winged ants of small size, since I have found them in all their societies, though, to be sure, only at a particular season, for there are other seasons when only wingless ants occur in the formicaries.

Many reasons, which I shall not yet present in detail, conspire to prove that the small winged ants are the males. But to possess incontrovertible proof of this it is necessary to have surprised the female and male in the act of copulation. Hundreds and hundreds of times I vainly sought for them in this condition. The formicaries which I kept in the transparent jars showed me nothing more in this regard than the field nests, the interior of which I was unable to observe after they had been disturbed. Nevertheless, it is not only very certain that the small winged ants are the males, but it is equally certain that their mating, which has remained concealed during a long series of centuries, is more easily witnessed than that of any other insect. Not only does this occur in brightly illumined places, but often

* Observe whether during the disturbance to which the ants are subjected, the large winged and small winged individuals care for the larvæ and nymphs. I feel sure that the winged ones do not do this. The observation is to be repeated.

† We should ascertain whether there are not small ants, not so small as the small winged individuals, which are not such, or whether the small wingless individuals may not be small winged individuals that have lost their wings.

under one's very eyes, notwithstanding the fact that the ancients have eulogized these little insects on account of their modesty, because they believed that they exchanged the caresses that lead to the multiplication of their species only in darkness.

Perhaps I should have learned nothing from the first chance opportunity of seeing two ants mating, if I had been less familiar with the ways of these small insects.[50] Being on the road to Poitou and finding myself on the levée of the Loire, very near Tours, on one of the first days of the month of September, 1731, I descended from my berlin, enticed to stroll about by the beauty of the spot and the mild temperature of the air, which was the more agreeable because the earlier hours of the day had been warm. The sun was within about an hour of setting. During my stroll I noticed a lot of small mounds of sandy and earthy particles rising above the openings that led the ants to their subterranean abode. Many of them were at that time out of doors; they were red, or rather reddish, of medium size. I stopped to examine several of these earthen monticules and noticed on each among the wingless ants a number of winged ones of two very different sizes. Some of them had abdomens no larger than those of the wingless ants, and to judge from unaided vision one of the larger winged individuals must have weighed more than two or three times as much as one of the smaller. Over the beautiful levée, where I was enjoying my walk, there appeared in the air in places not very far apart small clouds of large flies which flew about in circling paths. They might have been taken for gnats or craneflies or may-flies.[51] Often the small cloud hung in the air at a height within reach of the hand. I used one of mine to capture some of these flies and succeeded repeatedly in doing so. All I secured were without difficulty recognized for what they were, for they were winged ants like those I had found at every step on the small mounds of earth. But I observed — and the observation was as important as it was easy to make — that I almost invariably captured them in pairs. Not only did I almost always find in my hand one large

and one small ant, but most frequently I took them copulating and held them for some time before they separated. The small ant was resting on the large one just as among common flies the male while mating rests on the female. The posterior end of the small ant was curved downward so as to apply itself to that of the female and it adhered so firmly that force was necessary to separate the pair. The abdomen of this small male was scarcely half as long as that of the large female, so that it could cover only the posterior portion of the latter's abdomen. I compressed the abdomen of some of the large ants and caused clusters of eggs to exude.

In order, therefore, to see ants copulating it is not necessary to know the place in which they hide during the act. Since I first took in the air the pairs of red ants of which I have just spoken, it has been easy for me to secure copulating ants of nearly all the species of this country. The fine days of summer and autumn, those especially that are bright and sunny, and during which various kinds of flies form small swarms in the air, are also the days on which the winged ants take flight. But they are not always congregated in the air in a kind of vortex; more frequently they are found dispersed, though occasionally they are present in the air in such great numbers as to be visible far and wide over very great areas. Even when they are flying and are difficult to observe near at hand, they can be distinguished nevertheless, at least during copulation, from several flies that differ but little from them in size and shape. This is indicated by a peculiarity that has never deceived me. When what looks like a fly about the size of an ant, with a posterior enlargement from which something seems to be dangling, is seen in the air, it is almost certain that what is taken to be a single fly is really a pair of ants. If the fly that seems to have this kind of tassel at its hind end passes within reach of the hand and is successfully captured it will be found that the hand holds two insects, a large winged female and another very small but also winged individual, whose posterior end is hooked to that of the former.

It is therefore in mid-air that the nuptials must be cele-

brated of those ants that pass the greater portion of their lives underground and the remainder of their lives crawling on its surface or at most on walls, plants or trees. I have sometimes stood near a formicary, part of whose inhabitants were winged, at about two or three o'clock in the afternoon while it was still being warmed by the sun's rays. Then the winged individuals of the two different sizes issued from the earth, betook themselves, so to speak, to the roof of their abode and there, after being thoroughly warmed, strolled about in various directions, without, so far as I could see, any teasing of the large by the small winged individuals; that is, without any tender preludes to mating. Then one by one both the large and the small ones took flight. Soon the surrounding air was seen to be filled with them, and the large ones were seen each to have a small one dangling from its posterior end. Not only, therefore, do they remain aloft while they are copulating, but they actually begin the act in the air. Usually the female does not long remain alone. I have reason to believe this because along with the female and attached male which I expected to capture, and which I captured without their separating from each other, I have sometimes secured at the same time two or three additional males which, jealous of the good fortune of the first, apparently wished to supplant him, or were, perhaps, waiting till he left vacant the place that was the object of their desires.

Furthermore, I have always seen the ants return one by one to their formicary as they left it.[52] Thus it is in the air that mating begins and continues. Then it is the task of the female to support the male, contrary to what is found in the flies called demoiselles, among which the male carries the female.[53] Nature seems to have varied her combinations in all possible ways. The female ant flies in divers directions without being abandoned by her male, and sometimes carries him out of sight. Since it is impossible to follow continuously with the eyes even those that fly lowest, and since others crossing them cause them to be lost to view, I have never been able to ascertain how long the flight and

the mating may continue. I have seen some that alighted very near the formicary before separating.

It has therefore been established that the wings are necessary to the ants, both male and female, in order that they may mate, and it would seem that these organs have been given them solely for this purpose. At least it is certain that the females do not long retain their wings after they have been fecundated. The males also shed theirs, but it would seem that they retain them much longer.[54] Their wings are not useless, except on occasions when they fly through the air without succeeding in encountering females of their own formicary; for all appearances indicate that mating occurs only among ants born together, that is, among those of the same formicary.[55]

I will describe some of the observations, as easily made as they are decisive, that taught me that the wings, necessary throughout life to other animals provided with them, are necessary to the ants only during a portion of their existence, in order that the observations may be repeated by those who may care to do so. On one of the last days of the month of August, towards the hour of sunset, having noticed in the air a lot of ants belonging to one of the largest species of this country, I captured three that passed within reach of my hand. Two were mating, but the third was a female that was at the time without a male. I confined all three in a small box. They were very vigourous, and their wings were in perfect condition. When at about nine or ten o'clock on the following morning I opened the box to examine my ants, I saw that one of the large ones — that is, one of the two females — no longer bore wings, but that she had lost none of her vigour and vivacity. She then appeared to me quite like those wingless females that one finds in small numbers in the formicary and that are conspicuous by their size. I believed, therefore, I had reason to suppose that the latter had all possessed wings. I found the four wings in the box. They were in such good condition and so complete that I had no reason to believe that they had been torn off by the other ants. In order to remain so perfect they must have

fallen off naturally, as a leaf falls from a tree when the end of its petiole dries because the nutrient sap no longer enters it in sufficient quantity. Nothing was lacking to these four wings, which should have been torn in divers places had they been removed by repeated pulling. Finally, there remained not the minutest vestige attached to the ant's thorax; it was difficult to find even the cavities in which their basal ends had been articulated.[56]

On the evening of the same day on which I made the preceding observation, I confined a single very large winged female in a glass beaker. I did not observe her till the following day towards noon. She had then lost the two wings on one side, and when I returned to examine her about two o'clock in the afternoon, I found that the two wings of the opposite side had fallen off in turn. She seemed, moreover, not to have suffered in the least from the loss, but to be quite as well as any ant can be. Sometimes large winged ants, or females, are seen to lose their wings more quickly than did the two that were the objects of the preceding observations. The wings of some fell off almost at the moment when I captured them; but ants may sometimes be taken that delay much longer in ridding themselves of their wings. I captured two on a formicary made of particles of wood and placed them, like the last of which I have spoken, in a beaker where they remained eight whole days without losing their wings. I then transferred them to another beaker containing worker ants of their own species, by whom they were well received. One of them, however, died in two or three days, and some days later I was unable to find the other. Whatever may have happened, here were ants that had preserved their wings in the beaker for 12 to 13 days and perhaps longer, whereas others deprived themselves of theirs after 12 to 13 hours of imprisonment and sometimes sooner. One reason for this difference naturally suggests itself and seems to be the true one. One set of these ants had been captured in the air and even while copulating. Their eggs, therefore, must have been fecundated.[57] The others were taken on the formicary and perhaps before they

had made any use of their wings. Probably they had not yet submitted to the embraces of the male. What seems to indicate that they were to be regarded as virgins is that when I took them the tones of their colouration were feebler than they were some days later after I had kept them. Their abdomen and thorax became deeper brown in the beaker. It follows from this that they were only recently transformed at the time of their capture.

Of four or five males which I imprisoned in a glass tube with females that no longer bore wings, two lost theirs after two or three days. A journey which I was obliged to make prevented me from ascertaining the moment when the others ceased to be winged.

In the East Indies and in our American islands, observers have not remained so long ignorant as in our climes of the fact that winged ants are not winged throughout their entire lives. There they have frequent, indeed too frequent, occasions to see them lose their wings. In those unusually warm countries there are ants which, like our moths and like flies of several of our species, fly by night and congregate about the lights. The number of these nocturnal ants is exceedingly great, and they are extremely troublesome on certain warm evenings.[58] Then, while one is at table and wishes to have the windows open to allow the entrance of the fresh air for which one craves exceedingly, the ants also enter and cover the table-cloth and the dishes. When these ants singe their wings in the lights they do not suffer, because they are about to lose them anyway. Their wings usually remain between the fingers that touch them. Many of them drop their wings on the table on which they have alighted. After arriving on the wing they are not annoyed at having to leave on foot. This is what M. Rose, after his voyage to Martinique, assures me he has seen much oftener than he wished. It is also what M. de Cossigny tells me he has only too frequently observed at Pondicherry.

But there is nothing to be compared with the prodigious quantity of ants by which M. de Cossigny[59] was surrounded one night when he was obliged to wait at one of the gates

of the city above mentioned, till some one came to open it for him. There is nothing comparable, I should say, with this quantity of ants except, perhaps, the clouds of may-flies which, on certain nights in this country envelop one along the banks of several of our rivers. The torch that lighted him seemed to have attracted to him all the winged ants of the neighbourhood. Soon those that alighted on the ground, or those that fell because their wings were shed, accumulated in such masses that they could be taken up by the handful. Nor did the Indian servant who carried the torch fail to do this. He made a kind of bag of one of the corners of his sarong and put the ants into it as fast as he could gather them. M. de Cossigny asked him what he intended to do with so many ants, and he replied that he would make a good meal of them. M. de Cossigny, who was not tempted to indulge in such delicacies, failed to ask him how he would season the ants in order to make them a palatable dish. But divers correspondents have already informed us that the Indians of Malabar season them with pepper, that they cook them and make provision of them, which they keep for several days. Perhaps these ants have not the odour that is so displeasing to us in our species; perhaps also such an odour is to the Indians what the "high" aroma of a partridge is to us. M. de Maupertuis[60] tells us that in Sweden a liquor is distilled from ants, and that a few drops of it are placed in the glasses of beer of those whom one wishes to please. He says that at Upsala he drank beer containing this liquor and that it did not seem to him to be disagreeable.*

Considering the various tasks to which the worker ants devote themselves, such as that of dragging the heavy burdens at which they toil, and the arrangement of the narrow and often rude galleries in the interior of their habitation, especially when it is made of particles of wood, we should infer that wings would often be useless or even troublesome to them, incommoding them on a thousand occasions and being superfluous on others. For similar reasons

* Inquire further of M. Camus in regard to this matter.

it is an advantage to the females that have been fecundated to lose the wings, which were so serviceable to them before fecundation. Having once mated they no longer have to navigate the air, but are obliged to remain in the interior of the formicary, first, for the purpose of laying their eggs, and then of devoting to the hatching young the care they owe them. Finally, when the males no longer have females to whom they can make love, they have occupations very much like those of the workers. It is not fitting, therefore, that they should continue to bear wings.[61]

No matter how altered in appearance the males may be that have lost their wings, and although they may be found mingled with other ants almost as small as themselves, one can always be sure of their sex.[62] It is only necessary to compress with the fingers the abdomen of any ant whose sex is uncertain. Such pressure when applied to individuals of at least several species causes a packet of three oblong contiguous bodies to be extruded. Increased pressure forces these bodies to protrude more and more and eventually to separate from one another. They are all three scale-like blades, slightly grooved on the ventral side. The two on the sides have their borders rounded and fringed with hairs. The superior or median body is largest at its end, where it terminates in a kind of crescent between the scale-like blades of each side and the middle or superior blade. Thence there extends a long scale-like filet which is not detected till the blades have been sufficiently separated from one another. Structures like these are not found at the posterior end of the worker ants, which have no sex, nor at the posterior end of the females.[63] It is, moreover, with these structures, which are analogous to those of the scales of various other insects, that each male ant seizes in the air the posterior portion of the female and holds it fast while she transports him hither and thither.

There is, furthermore, some variation in the number and shape of the structures which pressure forces out of the posterior end of male ants of different species, but these elongate bodies are never found at the posterior end of the workers, nor at that of the females.

No matter how busy or how intense life outside the formicary may be, that within is no less laborious. When the ants retire into their habitation, at least during the seasons that are not too rigorous, it is not for the purpose of repose. It is there that the mothers lay their eggs, there that the hatching young become the great object of the solicitude of the workers, which are their nurses; and among insects and perhaps even among men it would be difficult to find any that are more attached to their nurslings and feel impelled to take such pains with them.[64] The eggs laid by the mothers are of a very different size from those long bodies that have a certain resemblance to the kernel of a pine-cone and to which the name "ants' eggs" is applied by the vulgar. On escaping from the abdomen of the mother, they are so small that when seen under a lens of four or five lines focal distance they seem to be no larger than the head of a very small pin. Notwithstanding the quantity of them that the mothers lay, one is never sure of finding them in a formicary either of small sticks or of pure earth. At least my endeavours to discover them have always been unavailing, but I have had recourse to an expedient that has yielded more satisfactory results. One sometimes sees running over the ground wingless ants that are conspicuous on account of their much greater size than that of the common sort of the same colour and of the same species. Knowing that these larger ants must be females that had lost their wings, it was natural for me to suppose that when seen running over the soil they are seeking to form an establishment where the posterity they are about to produce can be reared.[65] Several years ago I captured three of these ants on the first of July, with the intention of confining them in a place where, if they laid eggs, they could not very easily conceal them. This place was a beaker three inches high, in the bottom of which I had placed a bed of earth sufficiently moist to be of some consistency and not more than an inch thick. On this earth I failed not to place some small morsels of sugar, morsels of fruit and some dead insects. I took care that my three ants should be content with the lodgings I had provided for them,

so that they might carry on therein the more important of their operations. The first endeavours they made to escape were rendered futile by a cover to the beaker. They soon set about establishing themselves where I wished to have them and actually placed themselves in the most favourable situation. After entering the earth they excavated a cavity in common, about an inch in circumference and near the glass wall. Its floor was that of the beaker, from which they had removed the earth; above them the earth formed a kind of vault and was about five or six lines from the floor. I could therefore look into this cavity both through a portion of the side of the beaker and through a portion of its floor. I noticed that the three mother ants kept constantly to their apartment; if they left the earth it must have been at night, or if during the day very rarely, since I never succeeded in surprising them without. They seemed therefore not to care to seek the morsels which I had offered them; but perhaps the sugar, which had melted, penetrated to them and perhaps without leaving their cavity they may have sucked the earth which absorbed it. It is not certain, however, that they did not find some kind of sustenance in the very soil surrounding them, even if it had not been moistened with syrup, since we have seen that certain ants previously mentioned lived for a whole year in a beaker in which there was nothing but earth. Nevertheless, the three females seemed to do well. They performed certain movements whose meaning was not always clear to me, but often they busied themselves in enlarging the lodging and in smoothing the surface of the vault.

They had kept themselves more than three weeks in this subterranean cavity when for the first time, on July 21st,[66] I thought that I could perceive some eggs, but I was not very sure that I saw them till the 4th of August, when, having slightly shaken the beaker and having turned it to the side where the portion of it enclosing the cavity was not covered with earth, I caused a white mass as large as a small pea to fall on the glass. This mass, examined with a strong lens, seemed to be merely a collection of granules, each, notwithstanding

its magnification under the lens, no larger than the head of a very small pin, but appreciably longer, perhaps twice as long, and slightly curved, with one of the sides concave. The only doubt I could entertain was as to whether these little bodies were eggs or larvæ, but subsequent observations proved them to be eggs.

The external envelope, the shell of these eggs, like that of the majority of insect eggs, is membranous, and it is essential that it shall be of this nature. Like the eggs of certain sawflies,[67] of which we have spoken elsewhere, they must grow daily and do indeed grow very rapidly. These same eggs, which I examined the 21st of July with a lens of scarcely more than four to five lines focal distance, I examined the first of August with another whose focal distance was 30 lines. They then appeared as large under the latter as they had appeared six days before under the former. A growth so appreciable and so considerable enabled me to recognize them more certainly for what they were, and all the more certainly because I saw among them several newly hatched larvæ. I could, therefore, compare eggs that were still unhatched with the minute insects that had escaped from some of the others. The examination and the comparison had become still easier, because this cluster of the size of a pea, of which I have spoken, no longer existed. The eggs and the larvæ had become detached and were merely placed close to one another and no longer glued together in a cluster. The unhatched eggs were white and very smooth; no segmentation could be seen in them, whereas in the larvæ the series of rings of which the body of each is composed was easy to distinguish. The head, or the anterior portion was easily recognizable. It was curved, sometimes more and sometimes less, in the form of a hook towards the venter. The larva was as broad as an egg but longer. Finally, through the shell of some eggs which contained larvæ nearly ready to hatch, I saw very clearly the form of the larva nearly filling the cavity in which it was lodged, and the liquid destined to nourish it occupying the remaining space. Ants therefore lay eggs which are at first united in a small cluster.

Does the mother lay them all at once or does she lay them in packets as several may-flies lay theirs? Or does she attach to the first eggs that leave her abdomen those that she lays the following day? This my observations have failed to make clear.[68] There is at least a great likelihood that the packet of eggs in question was laid by a single female, by the single one of the three that had been fecundated. In another experiment I had two packets of eggs from two females which I had established like the preceding, in a beaker with its bottom covered with earth. And sometimes I have had more of these packets of eggs than of female ants, either because the same mother laid more than one, or because one of the packets had been later divided into two. All were not confined for so long a time in the beaker as the first lot before they laid their eggs. Some of them laid after four or five days.

It would be more important to ascertain how these eggs manage to grow.[69] Does the mother ant nourish them, so to speak, by moistening them? Does the black dot which I have detected at one of the two poles of the egg have the function of a mouth? Or is it not more probable that the moisture that penetrates the shell carries into the interior some nutrient juice? It is certain at least that the mothers take great care of the eggs and that they know the places most suitable for them. When I had caused a packet of eggs to fall on a spot where the beaker was very transparent, in order that it might be in a position where I could examine it more closely, the mother hastily removed it. She seized it between her mandibles and carried it elsewhere. In the very place to which she consigns it she fondles it, licks it, rolls it about in all directions. She probably never leaves it in the same spot for an entire day. She knows where the eggs will enjoy the most suitable humidity and moves them accordingly. In short, she seems to be occupied with them from morning till night.

If the eggs require care, the larvæ that hatch from them require much more. Under certain conditions I have seen 10 to 12 still very small larvæ which held together and

formed a small packet.* The moisture on the surface of each sufficed, perhaps, to keep them glued together.[70] There is nothing very remarkable about their form. They are usually white, but those of certain ants are greyish. There are, moreover, some inconsiderable variations among the larvæ of different ants. All lack legs and are not only unable to walk but unable even to drag themselves about. It is not even in their power to wriggle from place to place. Their body is composed of a series of rings. In some species the anterior is more tapering than the posterior portion, which is extremely swollen in comparison with the remaining parts and is preceded by a constriction. The head is armed with two mandibles.

We know that each republic of wasps owes its origin to a single mother that, without being aided, or even accompanied by another wasp, prepares a place where she constructs the cells in which she deposits her first eggs. This establishment which she has begun alone is peopled before the end of the summer by several thousand wasps of her species that owe their existence to her. We also know that the new republics of the honey-bees have a different beginning, that they are colonies composed of an already considerable number of bees, which is, however, subsequently augmented by the fecundity of the single mother that is found in the colony or swarm. My observations have not yet enabled me to decide whether the republics of the ants are founded, like those of the wasps, by a single mother, without the aid of any worker, or whether they are founded by one or several females that are accompanied by several workers for the purpose of taking charge of operations.[71] An establishment with only a single ant would not be easy to discover. At least, if it did not already contain nymphs we should not be able to distinguish it from a hole in the ground which an ant had entered for reasons unknown to us. I have seen formicaries, of the kind that are eventually several feet in diameter both horizontally and vertically, that were no larger than one's fist and which contained a

* To be reobserved.

number of ants proportionate to their size, but there was no indication that there had been a time when one of these ants, a mother, had been alone. Furthermore, I am more disposed to believe that in the new establishments of ants, as in those of bees, there are always workers, and I base this belief on the fact that the same mother lays a great quantity of eggs at a time or during a brief period. Now since the larvæ that hatch from these eggs are unable to go in search of the nourishment they require, their food must necessarily be brought to them, and this is why it does not seem possible that the mother can suffice. The larvæ that were born in my beakers always perished long before they attained the stage of metamorphosis, a result which I attribute in part to the fact that the mother could not by herself provide them with food. She would have to be aided by the sexless ants.[72]

The larvæ must be ministered to by a great number of workers and these must be, as they really are, very active. But the administering of suitable food at definite times or hours is only the least important of their good offices, for they must constantly watch over the larvæ and keep moving them about in order to get them into the most comfortable positions, without leaving them too long in the same spot. They endeavour, moreover, to place them where they can enjoy the air when it is of the most equable temperature — that is, either of the proper degree of warmth or of the proper degree of humidity — all of which requires that they carry the larvæ now towards the surface and now towards the bottom of the formicary. Finally, there are among insects none that require to be so constantly cared for as these larvæ, nor are there any that are, in fact, so fondly cherished. When they have completed their growth they transform into nymphs. The same rule applies to the different species of these larvæ as to the different species of caterpillars. Some of them, when they are ready to become nymphs, enclose themselves in a silken cocoon, which they spin in a manner that will be explained in the sequel, while others transform without making a cocoon.[73] The wasps and bees are relieved

of the cares they lavish on their larvæ as soon as they are closed up in their cells; they have nothing more to do for them after they have changed to nymphs. The ant workers are in a less happy predicament. To be sure, they do not have to convey nourishment to the nymphs, but they must nevertheless show them all the other attentions they show the larvæ.

The formicaries do not contain larvæ and nymphs at all seasons. It is only towards St. John's day that they are found in the nests made of particles of wood. We shall confine ourselves to these, because it is easier to follow them than the others during the entire course of the year, and because they are the most populous. When the interior of one of these formicaries is exposed in order to find the larvæ and nymphs, it is necessary to dig more or less deeply according to the hour of the day; and according as the previous weather has been dry or rainy, warm, or temperate these grubs and nymphs are assembled close together in the same spot, often in very great numbers. If any of them are found, they are apt to be found in considerable quantities; but the spot that is most suitable to them when the weather has been very dry will not be the same as the one in which they will be comfortable after a rain. Moreover, a certain degree of warmth is favourable. It is advantageous to them to profit by the heat that penetrates with the sun's rays into the interior of their habitation; but there are times when these rays would roast small insects whose flesh is so soft and tender, if they were placed too close to the summit of the edifice. They would be badly placed at noon where they might be favourably placed at seven or eight o'clock in the morning.* Hence on different days and at different times during the same day, the worker ants are obliged to carry all the larvæ and nymphs aloft or to carry them down below. Were we less familiar with the activities of ants, we should be amazed at their enormous industry, especially when we consider the prodigious quantity of larvæ and nymphs for

* Ascertain whether they are to be found at noon at a depth at which they are found in the morning.

which they have to provide. Some formicaries probably contain enough of them to fill a quart measure.[74] But when we watch these busy insects at work we cannot fail to admire their industry and we no longer wonder at their success in accomplishing very quickly what would seem to require a very long time.

I have often taken delight in making them move their brood, and it was a pleasure that was easily procured. Into a rather large glass beaker I threw indiscriminately ants, larvæ, nymphs and particles of wood from their formicary. It was almost filled and then tightly covered. The ants at once set to work to put every thing in order. The particles of wood were all moved one by one and arranged in such a way as to leave the roads open. The larvæ and nymphs, of which there were several hundreds and perhaps thousands, were transported to the bottom of the beaker and to the side that was darkest.* When I subsequently turned this same side towards the sunlight of the window, I instantly caused them to move the nymphs and larvæ to the opposite side. The transportation was often accomplished in less than a quarter of an hour.[75]

But in order to appreciate the diligence with which they carry the brood from one spot to another, it is only necessary to consider what happens in a damaged formicary in which a treasure so dear to them has been exposed. No matter how extensive or how thick the layer of larvæ and nymphs may be, only a few of either will be left after a quarter of an hour. Every ant seizes between her mandibles one of the small insects incapable of locomotion, departs with it from a spot where it seems to be insecure and deposits it at some distance from the formicary under a stone, a clod of earth or under some leaves where she feels that it will be our of danger. She forthwith returns to the formicary to get another. Each ant knows how to hold the tenderest larva, the softest nymph, in her mandibles without injuring it. One can hardly sufficiently admire the skill with which the ants handle

* Essential experiment to ascertain whether the ants care for the larvæ of another formicary.

them. When the storm has passed, when the curious observer who has destroyed the formicary retires, they return to work and re-establish it in its former condition. They remember the spots in which they left the feeble young for which they have such an intense affection, carry them back to the formicary and pile them up one on top of another.

Sometimes they fail to find them where they thought they had hidden them most securely. Men take advantage of all things. Those who rear partridges and pheasants know very well that the best food for these birds when newly hatched is what are vulgarly called "ants' eggs," that is, the larvæ and nymphs of ants.[76] They have noticed that the insects do not give them sufficient time to collect as many as they wish, that they are more diligent in carrying them away than is the collector in picking them up.* We may not be too sure that we are superior to the ants in subterfuge, but this is how we deceive them: Several cabbage leaves are placed near an ant-hill, which is then overturned from top to bottom with a stick or a spade, and the disturbance is prolonged with the aid of the same implement. The ants, endeavouring to save their larvæ and nymphs, feel that they cannot find a safer place to conceal them than under the cabbage leaves. They assemble and pile them up there, never suspecting that they are affording the ravisher who wishes to appropriate them the opportunity to seize them by the handful where the delicate insects are no longer mingled with the particles of wood from which it would be necessary to separate them if they remained in the formicary. They are, so to speak, "husked."[77]

The ants that build on the earth and with earth, but in the open air, those that conceal their earthen nests under pots or under other objects, those that remain in the earth, and finally even those that build with sawdust in the cavities of trees or elsewhere, have the same affection for their young as those we have just described. Swammerdam observed that some of the first kind, that were lodged in a clod of earth, during the course of the day moved their larvæ and nymphs

* Experiment to be performed.

completely round the clod in order that they might enjoy the rays of the sun throughout the day.[78] I have seen some of those that establish themselves under flower-pots bring their young out of the formicary at certain hours and carry them back again at others, and I have seen these solicitous removals practised both by the ants that remain under the earth and those that build with sawdust in the dryest places.

There are no ants that I have compelled to make more numerous and more thorough removals of their young and that I have been able to examine more closely, while they were moving, than those which, in order to profit by the warmth in the glass bee-hives, often made their lodgings between the shutter of one of my hives and its panes of glass. Whenever I opened the shutter under which they were nesting, I exposed all their larvæ and all their nymphs. Full of solicitude for both, they at once set to work to remove them. Less in order to assist them than to see if they would not abandon a spot in itself so favourable, but where they ran too great a risk of annoyance, I swept away both ants and brood and cleaned out the cavity. Often during the same day, or at the latest on the day following, I found the space between the shutter and the glass pane as densely populated with ants and as well provided with larvæ and nymphs as it had been the day before.

I spoke above of the little red ants for which the interior of a teasel-head provided a lodging sufficiently spacious, both for themselves and their nymphs, and which M. Bonnet kept for some time in his laboratory.[79] One day he thought he would please them by placing the teasel-head in the sun, but on being heated the ants departed in a throng, carrying their nymphs and hiding them in the soil of the pot in which the stem of the teasel had been inserted. The heat which M. Bonnet thought might be agreeable to them would have been fatal, at least to the nymphs, had the ants not known how to withdraw them from its action by concealing them in the soil.

Although I have succeeded in observing as closely as possible the ants that had larvæ to care for, I have been

unable to ascertain how many times each day they carry food to each of them. This food has never seemed to me to be anything but a drop of liquid* emitted by the nurse from her mouth and presented to that of the larva, which fails not to imbibe it because it seems to be administered only to the one that needs it.[80] I have never seen the workers give the larvæ such solid foods as pieces of fruit, the intestines of insects, etc. When they are not feeding the larvæ they are licking them, and seem to caress them or rather render them other services the utility of which we fail sufficiently to understand. The females also participate in all these cares, since, as I have already said, those that I kept in beakers, though without workers to help them, nevertheless looked after their larval progeny.

The precise time required for the complete growth of each larva during favourable seasons is unknown to me, but it would seem that they do not attain their full size till after several moults of the skin. I am led to this opinion by finding the moult-skins of different sizes at certain times in very great numbers. Several reasons, too long to deduce, also lead me to believe that at the end of 14 days or thereabouts the larva is in a condition to transform.[81] Some of them, as I have said, change into nymphs that have no need of concealing themselves in an envelope, but the nymphs of ants of many other species are not at their ease unless they are enclosed in a silken cocoon. Hence the larvæ, after completing their growth as such, know how to spin like many species of caterpillars.

For the purpose of observing these grubs in the act of constructing their cocoon I placed in a beaker a large number that were apparently nearly mature, taken from a formicary made of particles of wood.[82] I also placed with them some ants from the same formicary and some particles of the wood of which it was composed. As early as the following day I saw several cocoons entirely finished in the beaker. Each larva is able to complete its cocoon in 29 hours or thereabouts. But that same day I observed some larvæ and the

* Taste the liquid that leaves the mouth of the ant.

following days still more, each in the act of spinning. Up to the moment that a larva begins to spin, it has been unable to move from place to place; it has not, indeed, been able or has not desired to execute the feeblest movements, or has scarcely made other movements than those of the lips and other parts of the mouth, movements which it could hardly fail to make in receiving and swallowing the proffered food. Up to this time, in a word, it has remained almost constantly in the same attitude, but when it feels the need of making itself a lodging it becomes as active as any caterpillar while constructing its cocoon. It stretches out the anterior portion of its body from time to time, till it becomes tapering, then shortens it, bends it to the right or to the left or turns its head upward or downward. These various movements tend to distribute and attach the thread that issues from a spinneret situated like that of the caterpillar, on the posterior lip. The thread is so extraordinarily fine that one cannot hope to see it through the most transparent walls of a beaker. It is, indeed, scarcely visible even under a strong lens when the larva is held in the hand and near the eyes, while one end of the thread is issuing from the spinneret. Nevertheless the material of the cocoon, which is made of several layers of this thread glued together, is so dense that it might be taken for a membrane, were the manner of its production unknown.

The first loops of the thread, those that are employed as a foundation for the cocoon, have need of a support, because they cannot be assembled entirely in the air. Some of them have to be glued to solid bodies. When the cocoon is finished it is therefore found to be attached to these same bodies, which often happen to be particles of wood. I have seen some that were attached to the walls of the beaker.[88] But as we have already stated, there is a difference between the insect lodged in this cocoon and the chrysalis of the caterpillar in its case. The chrysalis is safe wherever the cocoon has been spun, but our larva would run the risk of never becoming an ant if the cocoon in which it is enclosed till its last transformation were to remain in the place where

it was constructed. The workers or nurses, which neglect nothing that may contribute to the preservation of the tiny creature that in a few days will aid them in their labours, detach the cocoon, as soon as it is completed, from the bodies to which it adheres. They then carry it to the precious depository that is to perpetuate their republic and render it more flourishing; to the place, namely, where they keep the larvæ of all ages and the other cocoons that have already been spun. They are always ready to carry these cocoons away with all the remaining brood, whenever the site is no longer favourable or when they judge that another site would be more appropriate.

The larva does not long delay before undergoing metamorphosis in the cocoon it has constructed. I believe that it remains for a day or two before shedding the skin that conceals the external parts proper to the ant. All these parts appear as soon as this skin has been stripped off: the legs are applied to the venter as they are in many other nymphs; the antennæ are drawn up over the first pair of legs; the wings, if the nymph is to become a winged ant, are easily recognizable and are also for the most part on the sides of the venter. The fresh nymph is extremely white but subsequently its white colouration becomes sordid and then acquires a pale brown or reddish tint. The faceted eyes take on more quickly than the remainder of the body a rather deep reddish colour. Both of them may be seen through the cocoon, where one remarks at one of its poles two black spots that seem to belong to it, but which are nothing but the two faceted eyes of the nymph. Finally, after several days, the precise number of which I do not know, though the time is rather short, the insect is in a stage to quit the very thin envelope that enswathes all its external parts. It quits these and becomes an ant whose mandibles begin to exercise themselves on the cocoon. They make an opening through which the young ant soon escapes.[84] If it is to be a winged individual, the wings are present at this time and need only to develop more perfectly. This is soon accomplished.

When the time comes for the ants to begin to leave their cocoons, each day witnesses the appearance of fresh individuals. The formicary becomes more and more populous, since the number of those that perish from a natural death or through accidents is much more than restored. The labour of enlarging the common abode proceeds apace, its circumference is expanded and if the nest is made of particles of wood, these are built up. But apparently the erection of formicaries is like that of our cities in that there is a limit beyond which it is inadvisable to enlarge them. When a formicary has become very populous with ants of all sexes, it is probable that there happens what happens in a hive of bees; a swarm is given off or even several, and apparently the new formicaries one sees arising each year over the countryside are due to such swarms.

It is only by means of such swarms that we can explain satisfactorily the singular expedition that the ants in our American islands make every year.[85] It has been described so uniformly by eye-witnesses that it cannot be open to doubt. Father du Tertre and also Father Labat, who really in the best and most truthful portion of his narrative merely copies the former, report concerning the ants of Martinique what Mlle. Merian[86] tells us about those of Surinam. For two or three consecutive days troops of these insects present themselves to visit the houses. They arrive in files so broad and so dense, so continuous and so long, that it is vain to endeavour to oppose their progress. But experience has shown that, far from coming to cause annoyance, they come only with good intentions. Father Labat assures us that all the doors are willingly opened to them on their approach. They overrun one after the other all the rooms of the house that they enter, from cellar to garret, and forage in every nook and corner of every room. Any room they choose to enter has to be abandoned to them, so that the human occupants retire. In the meantime they kill all the insects they encounter and clean out the house, but the most useful of their occupations is the destruction of the cockroaches.[87] They would render an important service to the dwellers in

every house if they could deliver them entirely from these pests, because there are many complaints in regard to them. When these ants have thoroughly overrun the house from top to bottom they leave it to enter that of a neighbour. They have been called 'ants of visitation' and they deserve the name. They do not become a nuisance, because their visits occur only once a year and are not, therefore, too frequent.

These ants certainly do not visit the houses out of politeness or from a spirit of curiosity. There is, moreover, nothing to indicate that they are indulging in a great hunt which they can carry out on so great a scale only once a year. What I imagine to be the most probable cause of such a visitation is that the ant-colonies of the American islands every year produce swarms at the same season and that every swarm before establishing a fixed abode delights to roam about and examine a certain tract of country in order that it may be in a position to choose a favourable situation for its habitation. Having once entered houses that happen to be in their path, they are, perhaps, induced to overrun them from top bottom by the quantity of prey they find in them.[88]

Mlle. Merian, who has drawn these ants, gives some enlarged figures of them on Plate 18 of her *Insects of Surinam*. These figures seem to represent their size more accurately than their form, since at least those without wings have the thorax swollen in three places, one at the point of attachment of each pair of legs. This is not the kind of thorax seen in our European ants nor in any of those that I have received from our islands in America.[89] Whatever be the interpretation of the figures of these ants, they are larger than the largest we have in Europe. They live underground and, to quote the very words of the translator, "they there make cellars which are sometimes eight feet in height and as well excavated as men could excavate them." They are like some ants I received from Cayenne, which may belong to the same species, with very long mandibles, as well developed as scissors, for cutting the leaves of trees. In fact they often use them for this purpose. And they do

this work at night; at least so much may be inferred from the fact, related by Mlle. Merian, that in one night they so thoroughly defoliate certain trees that they assume the appearance of our trees in winter, being reduced to mere whisks. She adds that as soon as they cut the leaves they allow them to drop to the ground, and that thousands of other ants awaiting them below seize and undertake to carry them to their formicary as food for their larvæ.[90] I should like to know whether all that Mlle. Merian says about this matter has been observed by her or whether she knows it only from the reports of others. I should also like very much to know whether she has herself seen what she tells us about the way they construct a bridge entirely of living parts in order to reach a place they could not otherwise reach, for the bridge that permits the ants to cross itself consists of living ants. It is in the very words of the French translator that I shall report a fact that should be carefully observed: "The first ant attaches herself to a piece of wood which she holds tightly in her mandibles, a second stations herself behind the first, to which she attaches herself, a third attaches herself to the second in the same manner, a fourth to a fifth, and thus in succession. And in this manner they allow themselves to be carried by the wind till the last one attached reaches the other side, and forthwith a thousand other ants pass over those that serve as the bridge."[91]

When the societies of ants of so many species, which we have compared with those of the Tartars, because they are always ready to quit the habitations they have made when they cease to be as suitable as they were at first; when, I say, these societies produce swarms, it is difficult to be sure that they are such. We may see that ants have arrived or have just settled in a spot where none was previously, but we remain in doubt as to whether the colony we see is a part that has separated from a more numerous society, or whether it represents a society that has immigrated as a whole to a new site. Ants that have fixed abodes, like those that make their nest of heaped-up particles of wood, may yield greater facilities for the solution of this problem. But the attentive

observer would have to have in his garden one of those large formicaries that are found only in the fields. Since he could examine it throughout the year and at all hours of the day, the moment of emigration would not escape him, if a populous colony left it, and he might succeed in beholding a swarm depart from a formicary as one is seen to leave a bee-hive. And even if the moment of departure of the swarm escaped him, he might be able to infer that the colony had produced a swarm, if he should find that it was decidedly less populous in the afternoon than it was in the morning. But all my efforts to establish one of these formicaries in my garden have been fruitless, although I took more pains to bring it about than others might have taken to eradicate it. It was in vain that I frequently transported the greater part of the inhabitants of some large formicary in very large beakers. These ants, which, for some days, seemed to settle where I wished them to, later despised all the comforts and attractions in the form of building and living facilities with which I provided them. Not only did they abandon their habitation, but they never showed the slightest desire to establish another in my garden, and, notwithstanding all my pains, apparently reached the open country, where they knew better how to satisfy their wants than in my garden.

Chance, nevertheless, to which we are condemned to owe the most curious observations, has perhaps enabled me to witness a part of what occurs during the departure of a swarm of ants. During the month of July, on a day when the sun was hot and while I was strolling about at high noon, in an avenue between trimmed hedges, I saw on the lawn between them some files of those large ants that build with particles of wood. I very soon noticed that these ants were not moving in two diametrically opposite directions as they are seen to move on trails that lead to formicaries when those that go to the fields to forage take the same routes as those that return with the booty they have collected. I noticed not only that they all moved in the same direction but also that they were for the most part laden: some of them carried

fragments of wood which they were dragging along with difficulty, while others carried only a seed or some seed-husk. But several bore a more precious burden. Each of these held between her mandibles either a larva or a cocoon enclosing a nymph. In a word, they seemed to be transporting everything that was essential to establishing a formicary and to putting it in permanent order. They were by themselves capable of fully populating it, since I followed now one file, now several files of ants which taken together would have extended over a distance of more than 780 to 900 feet.[92] This was certainly a migration, but as it is not common for ants of this species to migrate, it is probable that what I saw was a swarm that had detached itself from the main body with which it had been living hitherto.[93] If this was the case, the colonies that emigrate from formicaries are better equipped than those that leave the hives of bees. The latter carry with them nothing but their industry and share in none of the provisions to which they have contributed, but leave to the bees from which they separate all their wax and all the honey of the hive; whereas the ants seem to carry away all they can from the habitation they quit.[94] Before deserting those that are to remain behind, they take their part of the best provisions, since they carry away the nymphs that will soon be able to labour for the benefit of the new society. I could not determine whence all these ants had come. They seemed to have come from a much greater distance than the 900 feet over which I was able to follow them. Nor could I detect the place where they were to establish themselves, since the choice had not yet been made. They were still in a condition like that of a swarm of bees that is hovering in the air, because it has not yet chosen the tree on which it is suitable for them to congregate. I also found some of the ants, in groups of about 20, in certain places under the leaves where they were taking a short rest, while waiting for the place of reunion to be decided upon by the majority or by those that had a right to make such a decision, for perhaps this is a prerogative of the females.[95]

The ants of this species cannot lightly decide on the place

where they will establish their formicary. When they have worked so hard to construct one in some spot they become so attached to it that the most unfortunate accidents will not induce them to desert it. After curious passers-by have taken delight in breaking down the small mountain they have reared, have scattered the light materials of which it consists, and have razed it to a level with the earth, quiet is no sooner restored than they set to work to repair the extensive ravages. They labour to repair them with such ardour that in the course of a few days the formicary is as high as it was. If the edifice be a second time demolished, they again set to work to rebuild it. Finally, no matter how many times or how frequently they are compelled to submit to such ill treatment, they do not lose courage. It looks as if the greatest misfortune that could befall them were to abandon a site so extremely to their liking. Some have been known obstinately to remain when their formicary has been inundated by pouring buckets of water over it,* and have even held out against an altogether contrary and more cruel treatment, that of burning straw on their hill, which is itself partly inflammable.

Although their formicaries are rarely burned or inundated, they are very often overturned from top to bottom and this without other evil intent than a delight in seeing with what diligence they labour to repair the havoc thus wrought among them. At first the eyes can scarcely grasp the impressions made on them by the combined agitation of the prodigious number of tiny living bodies so close together and all moving with great celerity and in all possible directions. Later when the initial disturbance has slightly subsided and when they have begun to disperse somewhat, it is only necessary to look successively at different points either on the exposed portion of the formicary or among its ruins to behold a great variety of sights illustrating the different ways in which these small insects employ both their skill and their strength. Some of them most adroitly hold between their jaws a nymph enclosed in a cocoon, as a dog trained to retrieve holds a stick that has been thrown to

* Experiment.

him, but with this difference, that the cocoon held by the ant is larger than her own body. The great majority busy themselves with replacing little by little the materials required to cover the formicary. An ant that has found a particle of grass or a light fragment of wood often holds it upright like a taper by one end between her mandibles, and thus marches proudly along. Another that also holds by one end a heavier sliver of wood, carries it in front of her almost in a horizontal position. A still heavier piece of wood can only be dragged by another, and is sometimes held under her body. But others that have undertaken to transport a piece of wood of considerable size or weight in proportion to their bodies, walk backward in order to drag it with more force, and steady their hind legs in order to bring it towards them. Another may be seen in the act of disengaging a fragment from beneath particles of wood that partly cover it and inserting it in what seems to her a more appropriate place. Still others combine their forces and work in concert to push ahead of them an extremely heavy fragment. By persisting in such labours they succeed in a few days in re-establishing the formicary in its former condition.

At times of disturbance, at times of moving, or even on more peaceful occasions, an ant may often be seen carrying a burden more unusual than a particle of wood, a granule of earth or a pebble, and one that is neither a nymph nor a larva, namely, another ant.[96] But if this occurrence be unknown to the observer, it may happen many times before his eyes without his seeing it. The ant that is carrying one of her companions moves no less adroitly, and whether she be running or standing still, nothing more is seen than an enlargement in front of her head. She appears to be holding a seed or some other roundish body between her mandibles. This is due to the remarkable manner in which the carried ant is placed with respect to her carrier. One of the mandibles of the former is placed between the two of the latter and reciprocally one of the latter's mandibles is placed between the other's two mandibles. The carrier clasps with her mandibles the mandible of the carried ant, which is between them, and simi-

larly the carried ant clasps one of the mandibles of the carrier. The former thus holds fast by means of her jaws and is tightly held by those of her companion. It is only in this manner that she supports herself and is supported, for she makes no use of her legs to grasp her carrier. Although they might serve for this purpose they would be useless, since the great strength of ants is in their mandibles. The ant that is carried, therefore, holds her legs folded up and applied either to her venter or to her thorax. She also brings her abdomen forward and holds it under her thorax, so that she seems to be only a little brown packet. She remains constantly in this attitude while she is being carried, and this may be for a long time. I have occasionally seen a carrier make many a journey with her living burden under my eyes, after which I lost sight of her, either because she escaped to a distance or because she entered the formicary.

The ant that is carried is usually distinctly smaller than the carrier. I have often seen the former compel another to carry her by means of either caresses or threats, for however carefully I have studied the ants, I am still unable to distinguish among them a kind from an unkind procedure. Be this as it may, however, I have sometimes seen the one that wished to be carried place herself in front of the one she wished to burden with her weight and bite sometimes one, sometimes the other antenna, sometimes the head and sometimes the forelegs. The gentle nips with the mandibles may, perhaps, have been only caresses, but not so certainly a caress was what I sometimes saw when the one that had no desire to walk seized the hind leg of an ant that was trying to escape her and compelled her to stop in order to step round and confront her. When the former succeeded in getting into this position, an agreement was soon concluded.

At other times, on the contrary, I have more than once observed an ant, perhaps officious to excess, compelling another ant to be carried. The former bit the legs, the head and the abdomen of the latter, till she presented her mandibles and the reciprocal interlocking of their blades occurred.

As soon as this was accomplished the one to be carried curled her body in an arc and the other started off. The carriers are worker ants, and I believe that the carried are males. I have sometimes observed, nevertheless, that the carrier ant is no larger than her burden.* It was more especially among ants that were getting ready to leave their formicary that I observed those that compelled others to be carried, perhaps because they felt that the latter had no desire to follow to the new habitation or did not know how to find it.

Even when ants are under no necessity to busy themselves with repairing the damage done to their nest, they nevertheless do not remain idle, but work at enlarging its circumference and height, ceaselessly carry to it the materials that are to be arranged, etc. They know no days of repose, except those on which the rains compel them to remain inactive. They even utilize fine nights with profit.† They also have certain hours during the day for their expeditions, etc.

The surroundings of a formicary are on a small scale like those of a large city, with roads leaving it and leading in various directions, but more frequented than the roads of any city. Over some of them the files of ants keep passing continually throughout the day. Yet these small insects never get in one another's way; those going to the country do not interfere with the progress of those returning to the habitation. At such times an ant never stops unless its aid may be required by one of her companions. When she meets some of them that have too great a task in moving some heavy burden, she lends them a hand.[97] But when two ants meet on a little-frequented path, they seem to have something to communicate. When both stop and the one places her head near that of the other, one might be tempted to believe that they are apprising one another of something worth knowing about which they have found on their excursions.

The roads are recognizable not only by the files of travellers that pass over them, but also, quite apart from this peculiarity, because they seem to be worn down. Through being

* Observe whether these porters may not be males. † To be verified.

trodden, even by very small feet, they become smoother, and, as very commonly happens, when they cross a lawn they may be very easily distinguished from their surroundings, because the grass in them is less dense and its blades farther apart. Pliny[98] alleges that the ants, as a result of passing and repassing, wear down the pebbles that are found on their trails. He actually cites this fact as an example of what may be accomplished by oft-repeated actions, no matter how insignificant they may seem to us. This example, however, is not so conclusive as that afforded by the stones of our own thresholds in much frequented places. It is more certain that the attrition of our shoes eventually hollows out stones than that the feet of ants have the same effect on pebbles.

It is known to everybody that these insects leave on the bodies they touch an odour resembling that of musk, and which is better designated as "ant odour." It is unpleasant to us when we find it on the fruits they have gnawed, and it displeases us even more when we find it in preserved fruits and confections, which they are often induced to visit by their taste for delicacies and in which they are entrapped as in glue and perish. This odour seems to be very generally disagreeable, and becomes quite unendurable when the nose is brought to within a distance of six or seven inches of an uncovered formicary. Instantly one is compelled to withdraw one's nose, just as when a bottle of volatile spirits is uncorked near it. The odour that then diffuses from the formicary is so penetrating that it at once causes sneezing.

This fact teaches us that a great deal of volatile spirits is being continually exhaled from the bodies of ants.[99] It is peculiar to them, or at any rate there are few other insects that are similarly able to produce an exhalation so penetrating and so abundant. If anyone were inclined to believe that the mere congregation of other insects in such great numbers would produce an equally strong impression on our olfactories, he would soon see his error were he to place himself as near a hive of bees. This can be done with impunity on many occasions, as I have observed, after opening

one of the glass windows. Then an odour not pertaining to the bees is the only one perceptible; namely, that of the wax, an odour emanating from the combs and mingled with that of the honey they contain. The bees that I have kept by themselves in great numbers in driers,[100] or a kind of receptacles made of canvas netting, for experiments reported elsewhere, have, however, under certain conditions, emitted a disagreeable odour, but not nearly so strong as that emitted by the ants.[101]

Since it is hardly to be presumed that insects that exhale so much volatile salts contain within their bodies the least amount of such substances, it would seem that the powder of slaters[102] that is administered for certain human diseases, on account of the volatile salt it contains, must be less efficacious than that of ants. The slaters perhaps emit less odour than any other insect, but they are larger than ants, and the ease with which a rather large number of them can be captured in cellars is the reason for employing them in preference to many other insects more difficult to obtain. But the volatile salt of ants might not be serviceable in cases for which that of other insects is useful, if it be certain, as we are assured by chemists, that it has peculiar properties and is a single acid, whereas the other volatile salts, excepting that of amber,[103] are alkalis.

But we should not reproach the ancient physicians for having neglected the use of ants; they have at least called attention to preparations of them as excellent remedies against a great number of different diseases, whose enumeration here it would be useless to attempt.[104] Physicians of a much lower order than those who treat us, namely the veterinarians, use ants daily in curing horses that run at the nose in order to prevent them from developing glanders. A veterinarian of Poitou, of acknowledged skill in curing their diseases, in order to cure one of my horses that ran at the nose considerably, had placed in a barrel full of water as many ants, larvæ and nymphs as could be obtained from a large formicary. The insects were taken indiscriminately together with the particles of wood composing the formi-

cary. He made the horse drink this water for several days, at the end of which time it was cured. But was the cure due to the remedy? This is no more easily proved in this case than in many others that interest us much more.

During the entire year in this country it is possible to obtain ants of the species that builds with particles of wood. When the cold begins to become severe, they congregate at the bottom of the formicary; where they pass the winter and whence they will not come forth as long as it lasts, except in very small numbers and on days when their habitation has been thoroughly warmed by a bright sun.[105] But during the winter the formicaries made of accumulated earth or excavated beneath the earth become deserted. One may then search in vain in them without finding a single ant. Where are they then? As yet I can give no satisfactory answer to this question. According to all appearances they go deeper into the earth, to a depth to which the cold cannot penetrate. But I never succeeded in finding any of them at this season in the excavations I have made either for planting trees or for other purposes. Do they lodge even deeper than their burrows extend? One meets with no greater success in finding them when the earth is plowed up towards the beginning of spring, but as soon as the fine days begin to return they are seen to reappear. Even the gardeners assert that the ants foretell the continuation of fine weather. They then begin again to excavate their abodes underground or to build them on the surface with agglutinated grains of earth. I have been astonished to see that the ants which, during the fine season, knew enough to make their quarters between the panes and shutters of my glass hives did not remain in these favourable situations during the winter. Where could they have found a warmer one? Perhaps, however, it is too warm for them at a season when they might perish of hunger, if their transpiration were such as to require food at a time when they can find on the ground neither insects, dead or living, nor flowers, nor succulent fruits.

NOTES ON ANTS

August 8th, 1744. Yesterday about seven o'clock in the evening I was struck by the quantity of ants on the tiles of the roof over the entrance of the stairway to the cellar in my kitchen garden. As the edge of the roof is low and about at the height of the eyes of a man of ordinary stature, it was easy to see what was going on. The square surface of the roof is about . . . .[106] Most of the tiles and especially those of the five or six rows nearest the edge were covered with ants, and more were continually coming out between the tiles where their nest was situated. They also issued from the crevices of the wall very near the edge of the roof.

These ants were of a small, but not of the smallest species. They had the junction of the abdomen with the thorax reddish.[107] The number of the winged was more considerable than that of the wingless individuals, and there were as many of the large as of the small winged forms. Every moment some of both kinds were seen to come out from between the tiles. The number on the roof, however, did not increase appreciably in proportion to the number that were gathering there, or rather it did not increase at all, because from moment to moment, as I could see, some took flight. Some of them rose very high in the air. The evening was fine and the sun had been shining throughout the day, although the thermometer had not risen above 21½°. Until the sun set I saw ants departing from the top of the roof and saw none return on the wing; that is to say, only those that issued from beneath the tiles were to be seen. I left them when I found that it was growing too dark to observe them any longer.

Expecting that they would have to return to the roof after having been fecundated in the air, I returned with

tapers to examine the roof at 10 o'clock in the evening. I failed to find a single winged ant, and took scarcely four or five of those without wings. I returned this morning, the eighth, at half past seven. The habitation, so astonishingly populous 12 hours before, was entirely deserted.[108]

There are two questions to be asked in connection with this observation: namely, did all the ants, when I first saw them, depart to establish themselves in another spot; and was this spot chosen by the worker ants or by the winged individuals? And in either case how did the other group know the situation that had been selected? If they had all departed in a mass, like the bees in a swarm, there would be no difficulty, but to my knowledge some of them departed an hour and perhaps really several hours later than the others.

Does this not indicate rather that a dispersion of the ants was taking place, that each couple, male and female, goes forth to start a formicary and founds only a single family as a swarm instead of a hive?[109] There is, so to speak, among the ants, an infinity of swarms, each consisting of only one male and one female. But then what becomes of the workers? Are they distributed among the various couples, or do they continue to live together?

Were all these winged ants born on the same day? This does not seem probable. What determines them all to separate from one another on a particular day?

Ants in Formicaries of Sticks.[110]

In the beginning of April and, I believe, even earlier, I found some cocoons spun at the bottom of one of the beakers in which I had placed some ants brought from St. Maur. But what I saw with greater delight was an egg-packet at least as large as a pea. The ants, however, which I had disturbed by my movement of the beaker, soon decided to divide the mass into several parts, which they carried away to recesses in the formicary and hid from my sight. These eggs were slightly oblong, of a brilliant white hue

like that of all other ant eggs. It seemed to me that they were a little more pointed at one pole than at the other. It is, therefore, certain that the large ants of this formicary had laid them. I did not see them later.*

Towards the beginning of May these ants were in a pitiable state. They seemed to be all covered with galls, even to their eyes. Each gall proved to be a species of mite.[111] These galls were differently situated on different ants; some had more, some fewer of them, but there was none that had not at least 10 to 12, and some of them had more than a hundred. The mites were yellowish white. The sugar which was in the beaker provided a suitable food for the mothers. I counted about 30 on one side of the head of a single ant. One may infer from this that some of them were extremely small.

N. B. This note may be kept for the article on the mites.

N. B. M. Lyonet, in his *Theologie des Insectes*,[112] says that he has seen viviparous mites, and doubts whether they be not all viviparous.

I am not sure that ants void excrement. It seems to be certain that they void only very little and that not of solid consistency. I found none of it, either in the earthen formicaries or in those made of small sticks.

Ants. — It must be admitted, nevertheless, that there are ants that occasion some slight disorders in our gardens. Some of them love certain flowers before they open. Yesterday, July 14, 1743, I noticed some ants on various specimens of the large mallows known as hollyhocks, whose flowers are larger than the large roses.[113] Some of them have white, others red flowers. It was on three of the plants with white flowers that I saw the ants. There were about 20 congregated on each of the large buds that had not yet opened and whose petals were covered by the green sepals of the calyx. I soon observed that portions of some of the sepals had been gnawed. This was probably only for the purpose of reach-

* *Obs. in 1744. There is no doubt that the formicaries of sticks persist for more than a year.* June 29 I found at the edge of the Forest of Bondi the formicary which I observed there last year.

ing the petals, for the ants had burrowed into the mass of the latter.

These ants are of a larger size than the smallest that work in the earth. They are nearly black and shining.

Observe whether there be not in the inside of the buds something that attracts them.

Black Ants of the Smallest Species of those that nest in the Earth.[114]

I began to observe them the 12th of May, 1743.

There are no ants that work harder nor any that work more diligently.

The work they have been doing in the beaker differs from that they perform in the open fields. Most frequently the earth is perforated with several holes, into each of which one might insert a thumb. They were separated from one another by elevations, by a kind of monticules. These elevations, or monticules, collapsed and the holes were filled when I jarred the beaker on changing its place. This is what would happen to the formicaries out of doors when the wind blows over them.

Yesterday in the garden, the ants of this species both before, at, and after high noon kept their larvæ and nymphs an inch and a half or thereabouts beneath the surface of the formicary. At the same time mine were keeping theirs at the bottom of the beaker.

They are easily fed because they are extremely fond of sugar. They cover with earth the morsels of it that are given them. I wished to see them take some that was plainly exposed and therefore I suspended a large piece by means of a string tied round it. One end of the string, forming the loop was long enough to touch the beaker and to make a bridge for the ants to reach the sugar. It evidently annoyed them to have to make so long a journey. On the morrow I no longer saw the piece of sugar where I had suspended it They had taken to gnawing the string that held it in the air and it had fallen. It must have been a considerable task

for the ants to gnaw this cord. One can hardly fail to recognize the purpose for which they had done it, or fail to see that they know how to act differently according as circumstances require, for ants are not accustomed to cutting the supports from which foods that they like are suspended.[116]

I have measured them carefully. The workers, which were the only ones actually seen, are extremely small. Their length is not more than a line and a quarter. Seen therefore under my ordinary lens they do not seem to be nearly so large as our ants from the formicaries of sticks. I have called them black, but when seen under the lens they seem only to be very deep brown.

They are more deserving of observation than any of the others, not only on account of the ease with which they may be fed, but especially because all their activities can be easily followed in the beakers.

Their larvæ are of the kind that I have elsewhere described as bagpipe-shaped, or, if one wishes, they may be said somewhat to resemble a bird without wings, without legs and without feathers. I would only say that their anterior portion forms a kind of birds' neck at the end of which there is a head that might be regarded as terminating in a beak.

The body of the larvæ is always moist and even sticky. Is this due to the matter which it transpires or does it not rather derive the liquid in which it is bathed from the nurses that care for it? It is certain that they lick the larvæ continually. There are sometimes four or five at the same time occupied with licking those which are to become winged ants and which are huge masses in comparison with those of the worker ants. It is more natural to suppose that the ants that lick the larvæ endeavour to keep them covered with a liquid that is advantageous to them, than to suppose that they endeavour to withdraw a superfluous liquid from them, that is, to dry them. The tongue of our ants, which passes the softened sugar into their mouths, does not seem to be suited to drying bodies. Besides the advantages accruing to the larvæ, this liquid with which their bodies

are moistened is convenient for the nurses. Its effects prove that it is viscid. The workers sometimes unite the larvæ into a cluster, in which they are *all* held together by the liquid. I observed the effect of this sticky substance on one occasion of which I shall have to speak. I sometimes saw the greater part of the larvæ very far out of the earth and attached to the walls of the beaker. Not only did the viscosity of the substance resist the whole weight of a larva, but often two or three other larvæ were glued to it without touching the walls of the beaker at any point.[116]

When the ants withdrew their larvæ from the earth to glue them to the walls of the beaker, they did it no doubt for good and sufficient reasons, but these are the more difficult to divine, because all the larvæ are not treated in this manner. What proved this was the fact that I have often seen clusters that were on the floor of the beaker, but which they did not dream of removing. Only those were attached to the walls that were too moist and had need of being carried into the open air so that they might be under more sanitary conditions and in a position favourable to development. Sometimes nearly all of them were attached, and sometimes only a rather small portion. At other times, and especially when the floor of the beaker was too moist, I have seen workers content to carry their larvæ out on to the upper surface of the formicary; but if they desired the larvæ to be placed in a drier situation, they did not desire them to become too dry. When I caused the rays of the sun to fall on the beaker, they bethought themselves to place the larvæ under cover away from its action; they carried them away and buried them in the earth. It was at such moments that I saw 10 to 12 ants around a single larva whose weight was enormous in comparison with that of each of them. In concert they toiled at pushing it into some cavity where it would be under cover.

Little Ants.[117]

When the earth in the beaker has been levelled by shaking, the ants toil at making a great number of funnels in it. Each is a gallery leading to the floor of the beaker. The more of these galleries there are, the easier it is for the ants to find the larvæ and to extract them, so to speak, from beneath the débris. But when they have all been found and lodged the ants decrease day by day the number of funnels. In less than an hour I have seen them dig more than 15 or 16 funnels in a beaker four inches and a few lines in diameter, and on the following days there were not more than two or three.[118]

The bottom of the beaker is where they keep the majority of the larvæ and where they build arcades under which they conceal them. On the floor of these arcades they place pebbles and pieces of dry grass in order that the larvæ may be raised above the floor, but sometimes they place them on the floor itself.

The ants take the same care of the eggs that they take of the larvæ. We have said that the eggs are in packets and that they grow. Is it not the liquid with which the ants cover them that holds them together, and does not this liquid provide for their growth? However strange this supposition may seem, it may, perhaps, be maintained. Perhaps we should ascertain whether it is not through the skin that the larvæ imbibe their sustenance, and if the analogy between them and other insects be inadmissible, it might be admissible between these larvæ and the eggs from which they hatch. But it is difficult to convince oneself that the nurses carry nothing to the mouths of the young.

Is the affection of these nurses restricted to the larvæ that are born among them, that is to the larvæ of their own family, or does it embrace all those of their species?[119] Do they love their species with sufficient tenderness and generality to be disposed to lavish the same care on the larvæ of another formicary as they do on their own? In order to inform myself I took a dozen larvæ or thereabouts from a

formicary established in one of my beakers, and after having driven away all the ants that allowed themselves to be lifted out with them because they did not wish to abandon their larvæ, I placed the latter in a beaker containing a layer of earth an inch or thereabouts in thickness. I introduced into this beaker about a hundred ants taken from a different beaker from the one from which I had taken the larvæ. With these ants, which I had separated from their companions, I placed a single one of their own larvæ to see whether it would be treated otherwise than the strange larvæ. They taught me very soon that it is the general good of their species that inspires them and that their passionate affection is not confined to the larvæ of their own family. The larva belonging to the hundred ants was treated no better than the strangers. All were equally acceptable. They set to work to prepare them a lodging at the bottom of the beaker; and made a cavity to which all of them were carried. Several of these larvæ showed by their size that they were of the kind that transform into large winged females. It remains, perhaps, to investigate whether they would lavish the same attentions on larvæ that produce worker ants.

Little Ants.

Experiment. A fine experiment that will elucidate the complete course of the history of the ants will be to place in one beaker a mother without wings and in another several mothers with our small worker ants. The mothers without wings will probably have been fecundated, etc.[120]

Large Ants of Montigny.[121]

June 5th, 1743. Yesterday I found at Montigny the largest ants I have seen in the Kingdom. Their length and stoutness impressed me. I have measured them and find that they are nearly 9 lines long, and their abdomen is large in proportion. I thought they might be females from the formicaries made of particles of wood, but they actually represent a distinct species. I saw no formicaries consisting of parti-

cles of wood. All the ants which I supposed to belong to the same society as these large ants disappeared into the raised earth along the side of a ditch where there were a number of trails and where the ants seemed to have been burrowing.

With these large ants I observed and captured some of a smaller size, though still considerable, and which I regarded as the males. They are 6 lines in length. I neglected to take the workers.[122] I will do so to-day. The females have the head and thorax brown, nearly black; their abdomen is pale chestnut.

I placed them in a glass tube and covered one with earth. She did not leave it. It seems that she did not know how to burrow. Among these ants the workers are apparently charged with all the work of excavation.

I believe that they feed on plants or insects. They seem not to have paid any attention to the sugar which I gave them.

In the tube there were only two females and two males or workers. The two females are well but the two males or workers are dead. One of them, however, is still able to make some feeble movements with one of its legs, but they are not sufficient to turn it from one side to the other. Are the males more delicate than the females, or have they been killed by the latter? At any rate it was not for the purpose of eating them, for they had no wound in the abdomen.*

Although these large ants have mandibles or pincers proportionate to their size, they do not bite so severely, or their bites are not so painful as those of much smaller ants. Each mandible has five denticles, or five small teeth.

Pressure causes five little bodies to extrude from the posterior end of the males. I am not, however, very sure of the number. Four of them would seem to belong to the organ that is destined to fecundate the eggs.

What I have hitherto called the males are the workers. Yesterday, the fifth, I went to investigate the nests. Their po-

* The seventh of June one of the females in the beaker had her abdomen cut off. This abdomen *was carried about again and again by the ants from the afternoon till the following* morning. Was the ant killed? Several mothers still remain.

sition is sometimes indicated, like those of wasps or subterranean bees, by a very round hole, whose diameter is like that of the holes entered by the insects of which we have just spoken. Having seen some of these holes with more finished edges, I took them to be the entrances to the subterranean dwellings of the larger ants. I had sought these dwellings in vain. The ants were not so active as on the previous evening; it was not so warm; it even rained. But the holes of which I have just spoken enabled me to find them. Having removed the earth, I found that the openings were continuous with galleries that penetrated the soil. They were tortuous and branched from time to time. In some places they expanded to form more spacious cavities of irregular form, sometimes an inch and sometimes two or three inches in diameter. In each gallery I found one or two ants but no more. I believed them to be poorly populated, but I eventually reached the true habitation, which was about two feet lower than the margin of the ditch. Here was an old root trunk that had been reduced to plates of irregular shape and strangely contorted. The mandibles of the ants had fashioned these plates by hollowing out the roots.

In the habitations which I had not excavated so deeply as the preceding, I found larvæ of various ages, but none in a cocoon or in the nymphal stage. They were in rather elevated places under little arcades of earth.

The present season is probably the one in which the mothers start their establishments. What disposes me to believe this is that I found a mother ant, and she was the only one I found yesterday, in a hole that ended blindly at a depth of less than two inches. The walls of the cavity, where it was largest, were carpeted; that is to say, they had a lining of silk, so that they were rather thick, greyish and earthy. Nothing seemed to me to prove that they had been spun by the ant, but rather by some caterpillar and that the mother ant had profited by the cavity to begin her establishment.[128]

The rain, which compelled me to return, did not permit me to seek long enough to find the larvæ of the formicary

which I had traced as far as the root of the tree; nor did I succeed in finding any mother ants. That search will be undertaken today.

These ants bite severely when they are irritated. They are, however, more gentle, more patient than the common species.

Yesterday, the seventh, I destroyed the large formicary. I uncovered the root which the ants had hollowed out into plates, but I saw nothing more than I saw yesterday. I was unable to find a mother ant. They seem to die after laying their eggs.[124] The larvæ were in clusters, but lodged in different places more than three to six inches apart. While I was digging in the galleries of the same ditch I found two females, one of which still bore wings, in two different holes. Each female was alone in her hole, which proves that they are alone when they begin their establishments. I placed these two mothers in a beaker with four worker ants or perhaps workers and males(?). The smallest held or was held throughout the day by the female without wings. The pincers of the one were passed alternately between those of the other. Sometimes the small one forced the large one to walk towards her, sometimes the small one was dragged along by the large one. Whether these were caresses or conflicts, I am unable to say. I had already observed in another beaker a female and a smaller ant that held on to each other continually for more than an hour and a quarter; and at the end of that time I saw the small one, after separating from the female, accost another with her antennæ. Her mandibles seized the mandibles of the new female, and I saw them thus joined together for more than a quarter of an hour, and I know not how long they thus remained.

June 8th. The females are very shining; they have the head, the upper portion of the thorax and the posterior portion of the abdomen black; but the anterior portion of the abdomen is chestnut; the lower portion of the thorax is also of this colour. The workers have the upper portion of the thorax chestnut and there is less of this colour at the end of the abdomen.

Although one of the females has had her abdomen amputated, there are in the beaker at least two or three others that are not harassed nor caressed as on the first day and whose mandibles are no longer seized by those of another ant. The two females which I placed with four ordinary ants are also very quiet. The one that was captured with wings still retains them.

Ants from Formicaries made of Particles of Wood.

June 6th. Hitherto I have known only one species of these ants, but yesterday I saw a second species that did not differ appreciably in size. Those that I observed yesterday have the body more greyish, less black than that of the others.[125] The larvæ of the old species, which has long been known to me, spin red cocoons, whereas the ants of the new species make very white ones.

Five formicaries have been marked by posts driven into the earth; one, which is not very large, is in the great avenue, at the beginning of the avenue on the right, on entering; the others are in the first walk to the right and on the border to the right. These nests are extremely large.

Ants.

Piso,[126] edition 1658, p. 291, [has a long article on ants. In it he says he has observed that they acquire and shed their wings.

Marcgraf,[127] edition of 1648, p. 253, says that the ant called *Cupia* acquires wings and that it afterwards loses them. If what he says be true they should not fall off till it is time to lose them.

Ants.

[Rayger],[128] Ephem. Acad. Nat. Curios. 1694 Decen. 3, 1 Obs. 21, p. 27, [speaks of] winged females. He cites Bontius[129] on the remarks of Garcias Aberto concerning the ants that produce lac.

He cites also Marcgraf, book 7 of his *History of Brazil*, on enormous formicaries.

There it is said to be beyond doubt that the wings grow out of ordinary ants in their old age. He then speaks (that is, Rayger) of ants that appeared in prodigious numbers and fell to the earth and there lost their wings; that he had picked up some of them and had placed them in a bottle, where they suddenly lost their wings.

Acta. Ph. Eph. Vol. 2, year 1730, p. 304, on the ethereal oil of ants.

As a result of the day's work I would note that the large formicaries have only a certain number of entrances and that the ants stop them all up when they wish to retire into the formicary.[130]

Ants are impatient when they are seized; *they then bite* as severely as they can and bite powerfully, having very strong, long and broad mandibles. But the mandibles of ants of certain species are not what one has most to fear. They are armed precisely like the bees and the wasps, since they have a sting. Usually they defend themselves against us only with their mandibles, but there are species, and one *among* those of *which* Leeuwenhoek[131] *speaks, that have* stings. My species is not his.

I have made the observation that the ants at work during the month of June, namely the ones smaller than the workers, are probably males that have lost their wings.[132] I have not seen the mother ants, either winged or wingless, transporting pieces of wood

An ant thrown into a formicary is soon surrounded by several ants some of which seem to bite her abdomen and others her head, a performance that sometimes lasts more than a quarter of an hour, without the one that is attacked resorting to flight. Perhaps she is being caressed. They have never killed her, though they kill caterpillars.

Add to the passage in which I speak of their love for their formicary the fact that those that perished on the

cover of my bell-jar, may have been using it as their cemetery.

Whether there may not be matings in the air and others in the formicary, and whether the matings for which the winged individuals are necessary may not produce ants of a different kind.

The 26th of June, 1734,[133] I liberated the ants from the formicary of particles of wood, which I had kept in confinement for more than a year. There were among them, however, *some that had perhaps lived in confinement* only *since* the preceding All Saints' day. I found in the bell-jar, in which I had placed no winged ants, several larvæ that were very large but had not yet spun their cocoons.

Fleshy horns, observed in 1735, at the compressed hind end of the small wingless ants from the formicaries of particles of wood, and not found in the others.[134]

A kind of palette observed at the junction of the abdomen and thorax of the ants that collect particles of wood.[135]

I observed two stigmata very distinctly above each leg of the last pair;[136] I suspect that there are four nearer the head.

When I am engaged on the description of the ants, pages 69 and 70 of Ray[137] are to be reread. The reference to Swammerdam is given there.

Ants, when they meet, feed one another; one of them presents her tongue, which is licked by that of the other.[138]

Drawings that remain to be made: 1st. a formicary of particles of wood; 2nd. an ant's head and its appendages enlarged; 3rd. an ant sitting on its posterior and "preaching"; 4th. one ant carrying another; 5th. an ant carrying aloft in front of her a particle of wood; 6th. an ant walking backward and dragging a piece of wood that is too heavy. 7th. several ants occupied with the same piece of wood.[139]

Observations which I still have to make on the ants from the formicaries of particles of wood. I am still unable to distinguish the females. I do not believe that they exceed the workers in size so greatly as the females of other formicaries exceed their workers. In order to recognize the mothers clearly I shall have to remove the wings from winged ants of these formicaries of particles of wood.[140]

In 1742[141] I left at Réaumur, in a little frequented road that runs along a hedge from the first bridge in the meadow to the last mill of La Touche, a small formicary of particles of wood. It had only just been started. It is situated on the farther side of the hedge on the higher side of the road opposite the sixth tree counting from the highway. It will be advisable next year to ascertain whether it is still in the same place and whether it has grown in size.

I have left a much larger one in the field of L'Epremure where I have had some oaks planted to form an avenue.

When placing [in beakers] several winged ants that have mated, one should endeavour to see the wings fall off, in order to be sure that they fall like the leaves of a tree and are not torn off by the ants.

Subterranean mother ants placed in a tube of moderate size are more easily observed than they are in a beaker, no matter how thick the layer of earth may be.*

Whether the ants care for the larvæ and nymphs of another formicary — the experiment will be easily performed on formicaries of sticks.

Whether they work in the moonlight.

Try to make wood ants work under observation by keeping them in a beaker and giving them decayed wood.

For the purpose of ascertaining the tastes of ants of different species and to learn what they like best, they should be provided with a table well covered with morsels of various

* Works to be consulted: Piso, Vallisnieri,[142] Wotton,[143] Actes des Suèdes,[144] Power,[145] l'abbat fourmis de passage,[146] Leeuwenhoeck, Father du Tertre, History of San Domingo.[147]

kinds. This table will be an earthenware plate on one side of which drops of honey, syrup, and preserves, on the other hashed worms, meat, chafers, dead bees or wasps, caterpillars and spiders are placed. I can use this well-furnished table also in performing the experiment to determine whether ants communicate with one another. I shall place an ant on it, and shall place none on a similar table situated at a similar distance from the formicary. This will enable me to discover whether the ants inform one another and how much time it requires for them to profit by the information.[148]

Embed in a formicary some pieces of resin to see whether they will take on the peculiar quality that makes them resemble myrrh or amber.[149]

Place in a formicary a moist blue paper to see whether it will turn red.[150]

Endeavour to obtain some volatile spirits by placing a bell-jar in a formicary.[151]

June 10th, 1720. The night has been very beautiful and the moon has been shining continually. I went to see my large ants at six and half past seven in the morning. There were scarcely any of them on the formicary — that is to say, perhaps half a dozen. They have their hours for work and for repose. They had, perhaps, worked all night; but I also observed that all the entrances of the formicary had been stopped up, except a single one of very small size. At half past eight the majority of the ants appeared. They were busy opening all the entrances; that is, in carrying away the little pieces of wood with which they had been barricaded. It is to be noted that on this day the sun was bright and warm in the morning; it was not, therefore, bad weather that had detained them so late within the formicary.

Towards noon, at one or two o'clock, although the sun was not so bright and was often covered by clouds and had not therefore heated the formicary too much, nearly all the ants had gone inside. Hence noon is also one of their times for repose.

*On Exterminating Ants.**

Since ants are so fond of sugary liquids, the method seems to be easy. It is only necessary to poison the water in which the sugar is dissolved. Dissolve a little arsenic in it. Place this water in a vessel at the base of the trees which the ants are ascending. The water may evaporate, but it will leave the sugar and arsenic. It will only be necessary to replenish the water.

The weakest dosage of arsenic capable of producing this effect should be tested.[152]

Perhaps it would suffice and be better to make a syrup containing arsenic, to soak cloths in it and tie them around the trees. The ants will drink the sugar and poison themselves. Lye made from ashes.

Sloane[153] Ants. Plate 238; nest of wood ants with the covered gallery through which they pass.

A LETTER FROM LYONET[154] TO RÉAUMUR.

At the Hague, this 5th Dec. 1743.

Sir:

I beg your forgiveness for having delayed so long in answering your letter, but as I knew you were absent and that you do not like to be written to except when you are in Paris, I wished to await your return, which I did not learn till it was rather late.

I take the liberty, Sir, of sending you the cocoons for which you asked. Apparently you did not expect to receive such small ones; but no matter how small they may be, I am convinced that you will find them worthy of your attention. Since I have never found any that were not completely formed, I cannot tell you how the insect constructs them. Those whose eggs are not yet hatched are constantly guarded by a yellowish spider[155] much smaller than the cocoon itself. The spider remains at a distance of about an inch

* The whole article on the method of exterminating ants is still be be written or to be retouched. What has been done in Cayenne by M. Fresneau, the effects of soap, lye made from ashes, etc.

from the cocoon. I have never found these cocoons except attached to the under surface of oak-leaves, with the point directed downwards, and when I have placed them on the upper surface of the leaf the spider has lost no time in transporting them to the opposite surface. Such care adequately proves that they are the cocoons of this insect; but what prevents me from entertaining any doubts is that, having opened one of these cocoons in which there were 22 eggs, I saw escaping from them as many small spiders, and what appears singular to me is that, after having escaped from their envelopes, they lay motionless for more than 24 hours before leaving the spot. I have tried to rear them on flies, but as they had no desire to eat, I neglected them and they died.

I very much wish to see your seventh volume in print.[156] The beetles have been little studied up to the present time, on account of the difficulty of following their life histories and the time required in doing so. In regard to them, I am convinced, Sir, that you will introduce us into an unknown country abounding in marvels, but I have difficulty in believing that it will be as fertile as you have shown us to be that of the flies.[157] The ants, of which you will also treat, I believe, in the same volume, excite my curiosity no less. Although this animal has been more observed than the beetles, it is still very imperfectly known. I once began to study it, but I failed to continue. The only new facts they revealed to me at that time were, first, that they spin quite as well as the caterpillars, and second, that they refuse to admit to their society strange ants even of the same species. What made me suspect that they spin was, in the first place, the small masses of earth which they heap up around the entrance to their cellars, and which are each composed of a number of grains bound together. I saw that the ant, in order to form them, collects beneath her body by means of her legs and antennæ the separate grains she detaches while burrowing, and that after being collected they are held together and thus easily enable the ant to carry several of them at a time out of her cellar. But what has furnished me with an incontrovertible proof is that after having poured water into a beaker

nearly filled with earth, along the walls of which my ants had excavated, this water, entering their cellars, carried away the small amount of earth the ants had in many places applied to the beaker, and left exposed a quantity of filaments by which the earth had been bound together.[158] What makes me conclude that the ants refuse to admit stranger ants to their society is that I have on two or three occasions thrown a strange ant, that seemed to me to belong to the same species, into a beaker in which others were established. One of these, after having examined her, annoyed her for some time, till finally one of the troop detached herself from her companions in order to attack her in single combat. At the same instant the others moved aside and these two fought alone till one of them lost her life. I cannot say whether it was the assailant or the other, because I had not marked them; but the victor had no further combats to endure.[159] So fiercely is this kind of battle waged that the surviving ant often has a thousand difficulties in separating herself from her opponent, which, though completely dead, yet remains attached by her jaws to the legs or antennæ of the former. I have also observed that the head which I separated from the body of an ant that was killed, held fast for more than three days by her mandibles to the antenna of the victorious ant before the latter could rid herself of it. I greatly regret that I was never able to seize the moment when my ants escaped from their cocoons. This has prevented me from elucidating a fact concerning which I was curious, namely, whether it is not, as I suspect, the worker ants that open the cocoons of those that are about to emerge; because it was only cocoons guarded by other ants that produced any young and because those that I kept by themselves frequently died without hatching; because, moreover, when the empty cocoons are examined, they are found to be torn in shreds and not opened at one of their poles; and because the ants that emerge from them are all white, which is a reason for supposing that they are at that time in a feeble condition that would prevent them, perhaps, from being able to open their own cocoons. If the ants cannot emerge without the aid of their kin we

should know the reason why Swammerdam and others as well as myself have vainly endeavoured to induce the cocoons to hatch by themselves; and this would be a very odd peculiarity, that an ant should not be able to be born without a midwife.[160]

I hope, Sir, that you will pardon me if I could not decide to send any additions or corrections to M. Durand, for the reasons I have already had the honour to write you. Even if M. Durand were to maintain that he could send no copy of his edition to Holland,he could not prevent others to whom he furnished the book from doing so. Moreover, Sir, you would do me wrong to believe that without your knowledge you had incurred my displeasure by having been the occasion of this second edition. You have done nothing of the kind, and I feel only too keenly how obliging your procedure has been, so far as I am concerned, not to have, on the contrary, a very just appreciation of it.[161]

I owe you, Sir, many thanks for the acquaintance you have procured me with Count de Serati. He is a man of intelligence and of merit, in whose conversation there is much profit. An attack of fever having detained him here for some weeks, I have frequently had the honour of seeing him and have thus had the opportunity to acquire for him all the esteem and all the consideration that are his due. I hope, Sir, that your large black larva has changed into a beetle. But the time when they transform into nymphs is very critical.[162] It is difficult to make the larvæ of some species of aquatic beetles transform when they are confined in boxes or pots. They like better to be in the open air. I have succeeded in the transformation of several when I have placed them in my garden on earth that was somewhat stirred and covered with hay or moss. I enclosed the spot in which I placed them with four boards to prevent them from escaping. Perhaps the large larvæ may transform more readily if they are treated in the same manner.

I have the honour to be with all possible respect and consideration, Sir,

Your very humble and very obedient Servant

Lyonet.

ANNOTATIONS

ANNOTATIONS

1. Ulysses Aldrovandi (1522–1605). The reference is to his folio with the very ambitious title: *De animalibus insectis libri septem, in quibus omnia illa animalia accuratissime describuntur, eorum Icones ad vivum ob oculos ponuntur, tandemque etiam natura mores ac proprietates ita declarantur, ut quidquid de eis dici queat, facile inde innotescat*, Bononiæ, 1602, 767 pp., with woodcuts in the text. Ther was a second edition in 1638. He also published with Michel Gehler an *Encomia Formicarum*, Amphitheatr. Dornauvii 1. Both of these works seem to be rare.

2. The reference to Jerome has been looked up by my learned colleague, Professor George F. Moore, who sends me the following comments: "The passage to which Réaumur doubtless refers is in Jerome's life of Malchus (Ed. Vallarsi, Tome II, p. 41ff.), but, as not infrequently happens to quotations and references which are passed along from one author to another, he has not got the thing quite right. It was not Jerome that took a lesson from the ants, but the monk Malchus, whose story he took down from that worthy's lips and published for the edification of others. And it was not an incentive to a more active life in general that Malchus got from the ants, but a resolve to run away from his master and return to the monastery, where, as in the colony of ants, all work together and no one has any private property, but everything belongs to everybody." On looking up the passage in Aldrovandi, I find that it was he who attributed the story to Jerome instead of to Malchus and thus misled Réaumur.

3. "Olien" is obviously a mispelling for Ælian. Réaumur refers to his *De Natura Animalium* I, 22, where he tells us that historians have praised the Babylonians and Chaldæans for their astronomical knowledge, but the ants, without regarding the heavens or counting the days of the month on their fingers, have been endowed by Nature with the extraordinary gift of astronomical knowledge. On the first day of the month they remain at home, etc.

4. A charmingly satirical paraphrase of the following terse passage in the younger Pliny's well-known *Historia Naturalis* XXXVI, 30: "*Et quonjam ex diverso convehunt alter alterius ignara, certi dies ad recognitionem mutuam nundinis dantur. Quæ tunc earum concursatio! Quam diligens cum obviis quaedam collocutio atque percunctatio!*" It is strange that it did not

occur to Pliny that such market-days would be a perfect waste of time, since the ants must have even better opportunities for making mutual acquaintances while they are gathered in the nests every night.

5. The fact that many ants have near the entrance of their nests a kitchen-midden where they deposit the remains of their food, empty cocoons, dead ants, etc., doubtless gave rise to the myth that they bury their dead with funeral rites. Hence Pliny's (*loc. cit.*) statement that apart from man they are the only animals that exhibit this behaviour (*Sepeliunt inter se viventium sola, præter hominem*), and the anecdote of the philosopher Cleanthes related by Ælian in Book VI, 50 of his *De Natura Animalium*. The same anecdote is also related by Jonston (see Note 18) from Plutarch (*De Solertia Animalium*) as follows: "*Admirandum quoque, in quod Cleanthes incidit spectaculum. Venisse formicas de suo cavo ad aliud formicarum examen, formicam portantes mortuam, verba sunt interpretis Plutarchi,' ascendisse alias formicas, tanquam ad colloquium, rursumque descendisse. Id bis terve factum. Tandem has, rursum extulisse vermem, tanquam redemptionis precium pro mortua. Hoc illas accepto et reddito formicæ cadavere discessisse.*" Accounts of ant funerals persisted down to the middle of the nineteenth century. Frederick Smith (Proc. Linn. Soc., London, 1861) published details of the funeral rites of certain Australian ants observed by Mrs. Hatton of Sydney.

6. Thomas Moufet (1550–1604), an English physician. The full title of the work is : *Insectorum sive Minimorum Animalium Theatrum, olim ab Edoardo Wottono, Conrado Gesnero, Thomaque Pennio inchoatum; tandem Tho. Moufeti et ad vivum expressis Iconibus supra quingentis illustratum. Londini ex Oficina typographica Thom. Cotes. Et venales extant apud Guilel. Hope ad insigne Chirothecæ, prope regium Excambium. 1634, roy. fol.* On the composition of this rare work see Hagen, *Bibliotheca Entomologica,* 1862, p. 553.

The eulogy to which Réaumur refers comprises Chapter XVI of the second book and is given in English in part by Cowan (*Curious Facts in the History of Insects*, Phila., Lippincott & Co., 1865). As an interesting example of the kind of writing so prevalent in the seventeenth century I reproduce it: "Since, therefore, (to wind up all in a few words) they (the Ants) are so exemplary for their great piety, prudence, justice, valour, temperance, modesty, charity, friendship, frugality, perseverance, industry and art; it is no wonder that Plato, in Phaedone, hath determined that they who without the help of philosophy have lead a civill life by custom or from their own diligence, they had their souls from Ants, and when they die they are turned to Ants again. To this may be added the fable of the Myrmidons, who being a people of Aegina, applied themselves to diligent labour in tilling the ground, continual digging, hard

toiling, and constant sparing, joined with virtue, and they grew thereby so rich, that they passed the common condition and ingenuity of men, and Theognis knew not how to compare them better than to Pismires, that they were originally descended from them, or were transformed into them, and as Strabo reports they were therefore called Myrmidons. The Greeks relate the history otherwise than other men do; namely, that Jupiter was changed into a Pismire, and so deflowered Eurymedusa, the mother of the Graces, as if he could no otherwise deceive the best woman, than in the shape of the best creature. Hence ever after was he called Pismire Jupiter, or Jupiter, King of Pismires. . . .

"They do better in my opinion, who observe the Pismire, and grow rich by following his manners in labour, industry, rest and study. We read of Midas that he was the richest King of all the West, and when he was a boy, the Pismires carried grains of wheat into his mouth while he slept, and so foreshowed without doubt that he should be endowed with the Pismire's prudence, and should by his labour and frugality, gain so much riches, that he should be called the Golden boy of fortune, and the Darling of prosperity, *Aelianus*. And when the ants did devour and eat up the live serpent of Tiberius Caesar, which he so dearly loved, did they not thereby give him sufficient warning that he should take heed to himself for fear of the multitude, by whom he was afterwards cruelly murthered? *Suetonius*."

7. In Réaumur's day the most beautifully coloured exotic ants were still unknown. In the genera *Macromischa* from the Greater Antilles, *Chalcoponera*, *Calomyrmex* and *Iridomyrmex* from Australia and *Forelius* from South America there are a number of species with exquisite metallic green, blue or purple hues. A similar colouration is seen in one of our North American species, *Pheidole metallescens* Emery.

8. "White ants," or termites. So little was known about these insects in Réaumur's time that they could not be distinguished from the true ants. A recognition of their very different systematic affinities did not come till the close of the eighteenth century, with the work of the taxonomists and the observations on the habits of certain Indian and Ethiopian species by Koenig (1778) and Smeathman (1781). For other instances of confusion of termites with ants in Réaumur's *Histoire* and notes, see Notes 18, 26, 126, 127 and 153.

9. John Ray (or Wray), born 1628, died 1704, 1705 or 1706. Réaumur refers to his "*Historia Insectorum; opus posthumum, cui subjungitur appendix de Scarabaeis Britannicis auctore M. Lister F.R.S.*" Ex MSS. Musaei Ashmolaeani, London, Churchill, 1710, 4 pp. 4°. He gave the following names to the five ants which he recognized: *Formica maxima hippomyrmex*,

Formica media rufa, *Formica media nigro colore splendens*, *Formica minima rubra*, *Formica minor ex fusco nigricans*. These are now known respectively as *Camponotus herculeanus* L., *Formica rufa* L., *Formica fusca* L., *Myrmica rubra* L., and *Lasius niger* L.

10. Réaumur's great interest in the behaviour of insects rather than in the details of their structure and classification is more clearly revealed in the three following remarkable passages in the introduction to the first volume of his *Mémoires:* "*Ce qui nous suffit, ce me semble, et ce dont notre curiosité doit se contenter, c'est d'en connoître les principaux genres, et surtout de connoître ceux qui se présentent à nos yeux; de sçavoir ce qui leur est propre à chacun, ce qu'ils offrent de particulier, comment ils se nourrissent, les différentes formes qu'ils prennent pendant la durée de leur vie, comment ils se perpetuent, les merveilleuses industries que la nature leur a apprises pour leur conservation. D'ailleurs, j'avoue que je ne serois nullement touché d'une énumération bien exacte des especes de chaque genre, pussions-nous la faire; il me semble que c'est assés de considérer celles qui nous ont fait voir qu'elles méritoient d'être distinguées, soit par des adresses qui leur sont propres, soit par des formes rares, ou par quelques autres endroits frappants. Tant que cent et cent especes des Mouches, et de très-petits Papillons, ne nous offriront rien de plus remarquable que quelques légeres differences dans les formes des aîles, dans celles des jambes, ou que des variétés de couleurs, ou que des distributions differentes des mêmes couleurs, il me paroît qu'on peut les laisser confonduës les unes avec les autres.*" (p. 3.)

"*La partie par ou elle (l'histoire des insectes) m'a le lus interessé, est celle aussi à laquelle on sera plus generalement sensible, c'est elle qui embrasse tout ce qui a rapport au genie, aux mœurs, pour ainsi dire, aux industries de tant de petits animaux. J'ai observé autant que j'ai pû, leur differentes facons de vivre, comment ils se procurent les aliments convenables, les ruses dont plusieurs usent pour se saisir de ceux qui doivent être leur proye, les précautions que d'autres prennent pour se mettre en sûreté contre leurs ennemis, leur prévoyance pour se défendre contre les injures de l'air, leur soins pour se perpetuer, le choix des endroits où ils déposent leurs œufs, tant afin qu'ils n'y courent aucuns risques, qu'afin que les petits qui en éclorront trouvent à portée une nourriture propre, dès l'instant de leur naissance, le soin que d'autres ont de nourrir eux-mêmes leurs petits, de les élever. C'est sur tout cela, ce me semble, qu'on ne sçauroit rassembler trop d'observations.*" (p. 13.)

"*J'ai déja assés déclaré que la partie de l'histoire des insectes a laquelle j'ai été le plus sensible, c'est celle qui regarde leur genie, leurs industries; aussi leurs industries décideront souvent de l'order dans lequel j'en traiterai. J'ai crû, par example, qu'on aimeroit mieux voir de suite tous les insectes qui sçavent se vêtir, et qui son sur-tout remarquables par-là, que de les trouver dispersés en differentes classes, comme ils le seroient necessairement suivant les methodes de*

Swammerdam et de Valisnieri. Je sçais qu'il pourra arriver dans celle que je suis, que des Papillons, des Mouches, des Scarabés se trouveront réunis dans un même article; mais cet inconvenient n'arrivera pas souvent, et il m'a pas paru fort grand. La vraye utilité de l'ordre est de disposer les verités de manière que celles qui précedent aident à acquerir celles qui les suivent, et de mettre l'esprit en état de les mieux retenir toutes; on doit s'écarter de l'ordre general dès qu'il n'a plus ces avantages. S'il y a des insectes qui n'offrent qu'une seule action dans leur vie capable de les mettre dans notre souvenir, c'est par rapport à cette action qu'il faut les considerer. Il y a des milliers d'especes de Mouches, de Papillons, de Scarabés petits, pour qui on seroit fort indifferent, si on n'en entendoit parler qu'avec ceux de leur classe, et pour qui on s'interesse dans d'autres circonstances. Lorsqu'on remarque sur les feuilles d'un arbre une galle d'une forme singuliere, on est bien aise de sçavoir comment elle a été produite; on est bien-aise de connoître le Ver qui y est renfermé, qui l'a fait croître; et de sçavoir ce que ce Ver doit devenir. Ainsi je ne me suis pas embarrassé que les insectes qui sortent des galles fussent de classes differentes comme de celles des Mouches, de celles de Papillons, de celles de Scarabés, j'ai parle de plusieurs differentes especes de ces petits insectes en parlant des galles." (pp. 42–43.)

11. Réaumur's statement that all ants are social still holds good, without exception, although a great number of species of these insects have been discovered since his day.

12. If Réaumur here alludes to the Doryline ants (*Eciton*) of the American tropics there is in the remarks immediately following some confusion with European ants that merely abandon their normally permanent nesting sites when changes in temperature, moisture, etc., become intolerable.

13. This ant, which Réaumur studied more thoroughly than any of the others in the ancient province of Poitou and both here and elsewhere in his essay describes as making a formicary "*à brins de bois*" or "*à batonnets*," is the common mound-building ant of Northern and Central Europe, *Formica pratensis* Retz., the "*fourmi rousse des près*" of De Geer. It is often regarded as a subspecies of *F. rufa* L. As Donisthorpe (*British Ants*, 1915, pp. 269, 270) says, "*F. pratensis* is very like *F. rufa* in many ways and has similar habits, but as Schenck pointed out in 1852, it is not quite so fierce, and does not spray its acid so easily, and Forel says it has more need of sun, and can put up with a greater degree of drought. On the Continent it prefers to nest in meadows, fields, and along the borders of woods and hedges, indeed De Geer stated *pratensis* only occurs in fields and not in woods, and André also gives fields, borders of hedges, etc., though he says it is rarely found in clearings in woods. Wasmann points out that in Holland *pratensis* occurs more commonly in woods and copses than it does

in Luxemburg where it forms nests in more open places. . . . According to Forel, *pratensis* will live a little nearer to human habitations than *rufa*, and is sometimes found in gardens in villages in Switzerland. . . . The nests are similar to those of *rufa*, but smaller on the average, being not so high, flatter and composed of coarser materials, and sometimes occur in old tree-stumps which are covered by the hillocks. Nylander records nests in Finland made of bits of grass, birch twigs, etc., and Wasmann says that in Dutch Limburg they are generally covered with a layer of rabbits' excreta, this being very characteristic of *pratensis* in that region, and on the other hand in Luxemburg where rabbits are scarce, this ant uses the droppings of hares in a similar way. On June 28th, 1900, in the neighbourhood of Luxemburg he found a nest of *pratensis* which appeared to be covered with rabbits' droppings, but on closer observation he found that the layer consisted of the dried seed-heads of *Centaurea pratensis*." The colonies of *F. pratensis* are usually smaller than those of *rufa*, and the worker is usually darker, with a black spot on the upper part of the thorax.

14. It is difficult to identify the ant to which Réaumur refers, since its nest mounds were made of such very unusual materials. Perhaps they belonged to *Formica exsecta* Nylander or to one of its subspecies or varieties (*pressilabris* Forel or *foreli* Emery).

15. The ant referred to in this and the following paragraphs is *Formica rufa* L. I am unable to find any mention of a "Mr. Scullens" in the bibliographies of Percheron, Hagen or others. The author's name is very probably incorrectly spelled either by Réaumur or the transcriber. I am also unable to find mention of a Leipzig publication of 1720 on the "incense" in *rufa* nests.

16. This author is evidently Johann Siegesmund Elsholz, also called Elsholtius (1623–1688), who wrote on gardening and the flora of Brandenburg. The periodical cited is the *Ephemerides* of the Acad. Caesar. Leopoldina Naturæ Curiosorum, the first decennium (ann. 2–10) of which was published 1671–79 (or '80).

17. Additional notes on the "incense" found in *F. rufa* nests are given by Linnæus and De Geer. The former (Anmaerkningar öfver Wisen hos Myrorne. Vetensk. Akad. Handl. 1741 p. 37–49, ed. 2, pp. 36–48) says that the ants collect the resin of juniper, especially when the formicaries are old and are situated among bushes of that plant, that the pieces of resin are usually found with a perforation and that they are gathered and used as incense by the peasants, under the name of "wirak." This name is evidently the same as the German "Weihrauch" (incense). De Geer (*Mémoires* II p. 1066) gives an interesting description of the resin

and figures it (Plate 41, Fig. 15). He says that the ants "*montent et descendent continuellement le long du tronc et des branches du Pin et du Sapin. C'est sur ces arbres, et peut-être aussi sur le Genevrier, qu'elles amassent une matiere résineuse, une espece de mastic, qui n'est autre chose que la résine qui découle d ces arbres; les Fourmis la recueillent en petites masses de figure irréguliere et de grandeur differente, donc la coul ur est tantôt blanche, tantôt jaune et souvent d'un blanc sale; leur substance est plus ou moins dure selon qu'elles ont été amassées plus ou moins récemment; quand on les jette sur des charbons ardents, elles donnent une fumée d'une odeur très-agréable, comme celle de l'ambre jaune. Ce morceaux de résine se trouvent mêlés sans ordre avec les autres matériaux dont la fourmiliere est composée. On peut demander quelle utilité les Fourmis retirent de cette résine qu'elles apportent dans leur logement? J'ai fait jadis cette question à feu M. de Réaumur, et voici la réponse qu'il me fit: 'Je ne crois pas qu'il y faille entendre aucun mistere. Il n'est point de petit corps que quelques especes de Fourmis ne mettent en œuvre; petits fragments de bois, petits fragments de feuilles et de tiges de plantes, graines de divers fruits, petites pierres, tout ce qu'elles peuvent transporter leur est bons lorsqu'il est sous leur main. J'ai vû de petites fourmilieres construtes entierement de grains d'orge dont les Fourmis n'avoient pas envie de tâter pour se nourrir.' Voilà ce que M. de Réaumur m'écrivit sur ce sujet, et je suis absolument de son sentiment.*"

18. Johann Jonston, or Jonstonus, in his *Historia Naturalis de Insectis Libri III*, Francofurti, 1653, fol. Ed. 2. Amstelodami, Schipper, 1657; reprinted as *Theatrum universale omnium animalium*, etc. Amstelodami, Wetsten 1718, and Heilbronn, Eckebrecht 1768. Miall (*The Early Naturalists, their Lives and Work*, loco citato p. 50) says of this author: "John Jonston (1603–1675) was a weak successor to Aldrovandi, from whom he borrowed largely. His illustrated works enjoyed a great reputation, being republished or translated many times. Jonston was of Scotch descent, though born in Poland he studied both at Thorn and St. Andrews. To explain how this came about would require a historical discussion, in which the Wyclifites, Hussites and Moravians would all find a place."

The "Ch. Ovius" to whom Réaumur refers is not mentioned by Jonston. The author Réaumur had in mind is Gonzalo Fernandez de Oviedo y Valdes (1478–1557), whose well-known *Historia General de las Indias*, 1535, is twice cited by Jonston in his chapter on the ants at the beginning of the second book. But Oviedo's observations refer to the nests of termites (some species of *Eutermes*) and not to ants. The following is Jonston's description of the insects and their nests: "'*Semiformicas' quæ et semivermes, in Occidentale India invenies, Comixen indigenis dictas. Alba velut cauda prorepunt et ligna erodendo penetrant. Arbores vel parietes scansuræ,*

opercula terrea, digitum crassa secum ferunt, in iisque ad quatuor et ultra palmos productis, nidulantur."

19. The type of ant-nest here briefly described is very common in Northern and Central Europe but, according to my observations, extremely rare in other parts of the World. It is constructed mainly by certain species of *Lasius*, *Formica* and *Tetramorium* in open grassy places at low altitudes and may often be seen in Switzerland, France and Germany. Perhaps it is an adaptation to regions which, though sufficiently moist, are nevertheless deficient in insolation, enabling the ants to bring their brood into a position where it can get the maximum amount of heat without exposure to the light and wind. In the Mediterranean region and other parts of he world where there is, of course, much more sunlight, a higher temperature and less moisture during the breeding season, the same species of ants prefer to nest under stones. It is perhaps significant that Réaumur says nothing about such nests. Probably the conditions on his estate in Poitou were very similar to those in the Canton of Vaux, in Switzerland, where I have seen a similar prevalence of the type of nest he describes.

20. See Ælian, *De Natura Animalium*, Book VI, 43.

21. Ælian, *loc. cit. ibid.*

22. Réaumur is evidently here describing the carton nests of *Lasius (Dendrolasius) fuliginosus* Latr., a very interesting ant and not uncommon over the whole northern part of Eurasia from Japan to Great Britain. The description of the formation of the carton of fine particles of wood agglutinated with a secretion, now known to be that of the maxillary glands of the workers, is of considerable interest on account of Forel's remark (*Fourmis de la Suisse*, 2nd ed., 1920, p. 89) that Meinert (1860) was the first to find "*que le bois qui forme ses labyrinthes n'est pas du bois naturel miné ou sculpté, mais un carton composé de parcelles ligneuses agglomérées au moyen d'une substance secrétée par les glandes dont nous venons de parler.*" He also points to the fact that Pierre Huber (*Recherches sur les Mœurs de Fourmis indigènes*, Paris et Genève, 1810, Engl. transl. by J. R. Johnson, 1820, p. 50 ff.) still believed that the carton was merely wood excavated by the ants. We now see that Réaumur had correctly described the composition of the carton more than a century before Meinert.

23. See Lyonet's letter to Réaumur (p. 215) for some observations on the agglutination of particles of earth by ants.

24. The glass observation hives employed by Réaumur in his studies on the honey-bee are described in the fifth volume of the *Mémoires*, 1740 p. 219 ff. and figured on Plates 22 to 24. A beautiful vignette by Haussard

at the beginning of the first mémoire in this volume shows the arrangement of the hives in a garden and their use. On p. 709 there is the following account of the ants nesting under the shutters: *J'ai admiré souvent le choix que certaines fourmis avoient fait du lieu où elles s'étoient établies, de ce qu'elles avoient su en trouver un qui ressembloit des avantages que tout autre n'eut pu leur offrir. En ouvrant les volets de mes ruches vitrées, j'ai vu souvent de milliers de fourmis, qui étoient entre ces volets et les carreaux de verre; elles y avoient transporté leurs œufs, leurs vers et leurs nymphs, dont le nombre égaloit et surpassoit quelquefois celui des fourmis mêmes. Où auroient-elles pu trouver un endroit dans le jardin qui eût un pareil degré de chaleur et aussi constant?*

25. The description shows that Réaumur actually constructed for his ants the same type of artificial nest as that employed by Lubbock and since regarded as his invention!

26. The insects observed by M. Raoul were termites (*Reticulitermes lucifugus*).

27. The observations of Charles Bonnet (1720–1793) to which Réaumur refers are entitled *Observations sur de petites Fourmis qui s'étoient établies dans la tête d'un chardon a bonnetier* and were published in his *Insectologie* in 1745 and later in his *Oeuvres d'Histoire Naturelle et de Philosophie*, Neuchâtel, 1779–83, Vol. 1, p. 523 ff. They are quoted *in extenso* by Latreille in his *Histoire des Fourmis*, 1802, pp. 49–65. The ant was very probably *Leptothorax tuberum* Fabr. That the *chardon à bonnetier* is the fuller's, or draper's teasel (*Dipsacus fullonum* L.) is proved by Bonnet's figure (*Oeuvres d'Histoire*, etc., 1, Plate 6, Fig. 10). Since Bonnet's observations, though made as he informs us in August 1739, were not published till 1745, and since Réaumur's article was not written later than January 1742 (see p. xiv and Note 33), we must assume that Bonnet had sent Réaumur a full account of them, probably in 1739 or 1740. This is highly probable, because we know that Bonnet was for years one of Réaumur's many friends, admirers and correspondents. The Genevan philosopher and naturalist, in fact, always regarded himself as one of the French scientist's pupils.

28. In literature the well-known fable of the ant and the cicada goes back, of course, to Æsop, but it seems to have had a long anterior history even among primitive peoples. Mr. J. G. Myers calls my attention to the occurrence of a very similar fable among the Maoris of New Zealand. Best (*Maori Forest Lore*, Trans. New Zealand Inst. 41, 1908 (1909), p. 240), after remarking that "the cicada is treated in Maori fable as the personification of slothful carelessness and the ant as the emblem of industry and forethought," relates the fable as follows: "The *pokorua* (ant) said to the *kihikihi* (cicada), 'Let us be diligent and collect food during the

summer, that we may retain life when the winter arrives.' 'Not so,' remarked the cicada; 'rather let us ascend the trees and bask in the sun on the warm bark.' Even so, the ant laboured at collecting and storing food for the winter. The cicada said, 'This is true pleasure, to bask in the warm sun and enjoy life. How foolish is the ant who toils below!' But when winter came and the warmth went out of the sun, behold, the cicada perished of cold and hunger, while the ant, how snug is he in his warm home underground, with abundance of food!" Best appends the text of the Maori songs sung by the ant and cicada respectively.

29. It will be seen from this and the following paragraphs that Réaumur was one of the first to prove that the common ants of northern Europe do not harvest and store seeds. William Gould (*An Account of English Ants*, London, A. Millar, 1747) is usually regarded as the first to have made the same discovery (see Kirby and Spence's *Introduction to Entomology*, 3rd ed., II, 1823, p. 46), but Swammerdam had preceded both of these observers. It seems remarkable to anyone who has observed the very conspicuous activities of *Messor barbarus* and its various subspecies and varieties along the African and European littoral of the Mediterranean that these and other authors of the eighteenth and early nineteenth century should not have conceived that the unanimous and rather detailed accounts of the ancient and mediæval authors might refer to an ant peculiar to that region. As a matter of fact, however, it was not till W. H. Sykes (Trans. Ent. Soc. London 1, 1835, pp. 99–107) clearly described the harvesting behaviour of *Pheidole providens* Sykes (? = *indica* Mayr) in India, that the chorus of opposition to the statements of the ancients began to subside, and not till Lespès (1866), Moggridge (1873), Lincecum (1862, 1866, 1874) and McCook (1877, 1879, 1883) had published their detailed observations, the first two on *Messor barbarus* and *structor* in Southern France, the latter two on the species of *Pogonomyrmex* in our Western and Southern States, that the true state of affairs was finally recognized. It is, perhaps, fortunate that the statements of so great an observer as Réaumur remained unpublished and could not be cited by the opponents of Solomon, Ælian, Pliny, Plutarch, Virgil, etc.

30. The statements of Plutarch, Pliny, Ælian, Aldrovandi, etc., that the ants (*Messor* sps.) gnaw the radicle of the seeds they store, so that they fail to germinate, were confirmed by Moggridge. This habit, however, is by no means universal among the grain-storing species. The seeds garnered by our American species of *Pheidole* and *Pogonomyrmex* often germinate *in situ* during prolonged wet weather and are therefore no longer of any use to the ants.

31. A vessel called a "poudrier" was in general use by eighteenth-

century entomologists (Réaumur, Bonnet, Lyonet, De Geer) for making observations on living insects. Littré defines it first, as "a small box in which the powder used in blotting script was kept," i.e., a sand-box, and second, as "an earthen vessel used by naturalists in their laboratories." Réaumur (*Mémoires* I, p. 45) describes it as follows: "*Des bouteilles de verre, telles que celles des cabinets des curieux, dont l'ouverture a presque autant de diametre que le fond, et qu'on apelle des 'poudriers,' sont des logements convenables; leur parois permettent toujours de voir l'insecte qui y est renfermé.*" A "poudrier" is clearly figured on Plate 47 of the sixth volume of the *Mémoires*, and Bonnet presents a very similar figure of "*un de ces vases de verre connu des Naturalistes sous le nom général de 'poudrier'*" on Plate I of the first volume of his complete works. These figures show that the "poudrier" was made of thin, very transparent glass and precisely in the form of the beaker used in our chemical laboratories, except that the slightly reflected rim had no spout. I have therefore translated the word "poudrier" as "beaker."

32. It was Réaumur who discovered the trophobiotic relations of ants to Aphids and Coccids, but his views have suffered some correction. He was not clear about the source of the honey-dew in the Coccids, and in the Aphids he derived it not only from the alimentary canal but also from the cornicles. Forel (Bull. Soc. Vaud. Sc. Nat. 14, 1875, pp. 33–62) showed that in the Coccids the saccharine liquid has the same source as in the Aphids, and Büsgen (Jen. Zeitschr. Naturw. 25, 1891, pp. 339–428) called attention to the fact that the cornicles of the Aphids do not furnish food for the ants but instead secrete a sticky substance which prevents the attacks of Coccinellids and Chrysopids. Other observers deserving mention among the many who have studied the trophobiotic relations of ants to Aphids and Coccids are Leche (1762), Pierre Huber (1810), Lichtenstein (1884), Lubbock (1888), S. A. Forbes (1894, 1905, 1906, 1908) and Mordwilko (1901, 1907).

33. André Hercule de Fleury (1653–1743), bishop of Fréjus, became cardinal in 1726 and acted as prime minister to Louis XV from that year to the time of his death. There seems to be some flattery in Réaumur's remarks. Although de Fleury has been praised for administering the finances of the Kingdom with probity and a frugality bordering on stinginess, historians have dealt much less leniently with his other activities, notably with his unfortunate meddling in connection with the Austrian succession, his harsh treatment of the Jansenists and his obstinate retention of his office when he was so old and mentally enfeebled as to be quite unfitted to perform his duties. At the very time Réaumur was writing there must have been many in the prelate's entou-

rage who were very far from indulging in prayers for the lengthening of his days. This is clear from d'Argenson's account of his death (*Journal*, etc., *loc. cit.*, Vol. II, p. 269): *M. le cardinal de Fleury mourut enfin hier à midi* [Jan. 29, 1743]. *On n'avoit jamais vu d'agonie si comique, par toutes les chansons, épigrammes et demonstrations, qui se faisoient jusque dans l'antichambre, et même la chambre du mourant, sur lui et sur M. Cassegrain, son directeur.* Cardinal de Fleury was twice president of the Academy of Sciences, in 1727 and 1738. The observations attributed to him by Réaumur are similar to those recorded by more recent observers (Leuckart, Wasmann, Ern. André and Turner). For an interpretation of this form of behaviour see my *Ants, their Structure, Development*, etc., 1910, p. 540.

34. The statement is on p. XV of the third volume of the *Mémoires: Pour parvenir à trouver les pucerons les plus cachés, il n'y a aussi qu'à prendre les fourmis pour guides, il n'y a qu'à les suivre: elles ne haissent pourtant, ni elles n'aiment les pucerons; mais elles sont avides de la liqueur sucré qu'ils font sortir par leurs deux cornes et par leur anus.*

35. Æneas Silvius (Enea Silvio Piccolomini, 1405–1464). The lacuna in the manuscript is easily filled. Concerning the battle between the ants Silvius says : "This action was fought in the pontificate of Eugenius the Fourth, in the presence of Nicholas Pistoriensis, an eminent lawyer, who related the whole history of the battle with the greatest fidelity."

36. The name should be written "Arture." According to Abbé Rozier (*Nouvelle Table des Articles contenus dans les volumes de l'Académie Royale des Sciences depuis 1666 jusqu'en 1770*, Vol. IV, 1776), he was *médecin du Roi* at Cayenne and was appointed a correspondent of Réaumur in 1753. During the same year he published in the *Histoire* of the Academy an article on the *ver macaque* (*Dermatobia*).

37. Réaumur here touches on an unsolved riddle in the history of economic entomology. There are two ants, *Formica omnivora* and *F. saccharivora*, both described by Linnæus in 1767, but still unidentified by myrmecologists. The former, according to historians and travellers, was exceedingly destructive in several of the West Indian Islands during the sixteenth and eighteenth centuries. An account of the devastations wrought by *Formica omnivora* L. (*Myrmica omnivora* Latr.) is contained in R. H. Schomburgk's *History of Barbados*, 1848, and as it seems to me to throw a good deal of light on the identity of the ant and seems never to have been noticed by myrmecologists, I quote it *in extenso:* "It is recorded by Oviedo and Herrera, that the whole island of Hispaniola was almost abandoned in consequence of a species of ant which in 1518 and the two succeeding years overran that island, devouring all vegetation and causing famine to the inhabitants, which nearly depopulated

the Spanish colony. A tradition prevails in Jamaica, that the town of Sevilla Nueva, which was founded by Esquivel in the commencement of the sixteenth century, was entirely deserted for a similar reason. Innumerable ants which destroyed all the provision-grounds of the inhabitants, produced great scarcity, which event, it is said, occurred about the same time that these minute animals committed their ravages in Hispaniola.

"They showed themselves about 1760 in Barbados, and caused such devastation that 'it was deliberated whether that island, formerly so flourishing, should not be deserted.' Martinique was visited by these ants in 1763. They made their appearance in the island of Granada about the year 1770 on a sugar-plantation at Petit Havre, where they were supposed to have been brought from Martinique in some vessel employed in smuggling. Barbados, Granada and Martinique suffered more than any other island from this plague. In Granada every sugar-plantation between St. George's and St. John's, a space of about twelve miles, was destroyed in succession, and the country was reduced to a state of the most deplorable desolation. Their numbers were so immense that they covered the roads for many miles together; and so crowded were they in many places, that the impressions made by the feet of the horses which travelled over them would remain visible for a moment or two, until they were filled up by the surrounding swarms. It was observed that these ants made their nests only under the roots of such trees and plants as could not merely protect them from heavy rains, but at the same time, being firmly fixed in the ground, afforded a secure basis against any injury occasioned by the agitation of the usual winds. The sugar-cane possessed these qualifications in a high degree, for a stool of canes is almost impenetrable to the rain, and is firmly fixed to the ground. The trees of the orange-tribe afforded these insects similar advantages from the great number and quality of their roots, while those of the coffee, cacao, plantains, etc., being less numerous and incapable of giving protection, were not molested. It did not appear, according to Mr. Castles, that these ants fed on any part of the canes or the leaves of the trees, as no loss of substance in either the one or the other had ever been observed; nor had they ever been seen carrying off vegetable matter of any sort. It is therefore concluded that the roots were injured by them so as to be incapable of performing their office of supplying nourishment to the plants, which became sickly and stinted and ultimately perished. The sickly canes, during the prevalence of this plague in the islands, did not afford juices fit for making sugar in either tolerable quantity or quality.

"The insect is the *Formica omnivora*, Linn.; its size varies much; the

size of some is scarcely a line, and others are nearly four lines in length. They are of a dark brown colour, somewhat shining, slightly covered with hair, the head large, flatly arched, and rounded towards the upper portion. On each side of the head is a minute flat eye, scarcely observable; antennæ are placed in two notches immediately over the upper lip, and consist of one long and eleven very small joints. The most important parts of this insect with which they commit so much devastation, are the mandibles, which are very strong, corneous, broad, arched outwardly, and sharply dentated on the interior side. The collar is laterally compressed, arched above and divided into two segments, of which the anterior is larger, and the posterior provided with a small knot. The peduncle which connects the abdomen with the thorax consists of two rings formed like two flattened scales, laterally compressed and concave above. The abdomen is smaller than the head, oval, and more hairy towards its posterior part. The feet are of a lighter colour than the body, and are very long; there is a small spine on the lower part of the tibia. When a number of them were rubbed together between the palms of the hands, they emitted a strong vitriolic sulphureous smell. It is asserted that they feed entirely on animal substances; for if a dead insect, or animal food of any sort was laid in their way, it was immediately carried off. Carcases were attacked as soon as they became puttid, so as that they could separate the parts, and soon disappeared. But they likewise attacked living animals; I have been assured that it was with the greatest difficulty that the young of any animal could be raised at that period. Calves, pigs, and chickens when in a helpless state were attacked, and their eyes, nose, and mouths being filled with large numbers of these ants, they perished, when not timely assisted. It became necessary to guard the eyes of the cattle and other animals by a circle of tar; without this precaution numbers were blinded. It is even asserted by Dr. Coke that the greatest precaution was requisite to prevent their attacks on men who were afflicted with sores, or women who were confined in child-bed, and on children that were unable to assist themselves. It may therefore be supposed that every exertion was made to put a stop to the ravages of these insects. Poison and fire, although they proved not entirely effectual, checked the rapidity of their increase. Arsenic and corrosive sublimate were mixed with such animal substances as they had been observed most greedily to devour. Corrosive sublimate appeared to have the effect of rendering them outrageous, and they attacked and destroyed each other. But still more remarkable was the destruction of great numbers by fire. It was found that when wood was burnt to the state of charcoal, without flame, and immediately taken from the fire and laid

in their way, they extinguished the burning coals by the amazing numbers which rushed upon it. Mr. Castles says — 'This part of their history appears scarcely credible, but on making the experiment myself, I found it literally true. I laid fire as above described, where there appeared but few ants, and in the course of a few minutes thousands were seen crowding to it and upon it, till it was perfectly covered by their dead bodies. Holes were therefore dug at proper distances in a cane piece, and fire made in each hole: prodigious quantities perished in this way; for those fires when extinguished, appeared in the shape of mole hills from the numbers of their dead bodies heaped on them.'

"The destruction of myriads in this way seemed nevertheless to make but little impression, and the devastation continued. In 1776 the government of Martinique offered a reward of a million of their currency for a remedy against this plague, and the Legislature of Granada offered £20,000 for the same object; but all attempts proved ineffectual, until the hurricane in 1780 effected what human power had been unable to accomplish. The Sugar Ant disappeared before the violence of this tornado.

"It has been asserted that this insect had been brought to Barbados from Tobago in some mould imported by Mr. Gidney Clarke, owner of the Bell Plantation. In 1814 they again made their appearance with considerable injury in many districts to the vegetable productions and feathered stock, but they did not continue long. They are still to be found in Barbados, but only in small numbers."

In Hispaniola, where the same ant was causing the devastations to which Schomburgk refers, the people adopted a very different method of dealing with it, as shown in the following passage from Cowan (*Curious Facts in the History of Insects*, 1865, p. 166): "Herrera relates that in order to get rid of this fearful scourge in Hispaniola, the priests caused great processions and vows to be made in honour of their patron saint, St. Saturnin, and that the day of this saint was celebrated with great solemnities, and the Ants in consequence began to disappear. How this saint was chosen, we read in Purchas's Pilgrims: "This miserie (caused by the Ants) so perplexed the *Spaniards*, that they sought as strange a remedie as was the disease, which was to chuse some Saint for their Patron against the Antes. *Alexander Geraldine*, the Bishop, having sung a solemne and Pontifical Masse, after the consecration and Eleuation of the Sacrament, and devout prayers made by him and the people, opened a Booke in which was a Catalogue of the Saints, by lot to chuse some he or she Saint, whom God should please to appoint their Advocate against the Calamitie. And the Lot fell upon Saint *Saturnine*, whose feast is on the nine and twentieth of Nouember; after which the Ant damage became

more tolerable, and by little and little diminished, by God's mercie and the intercession of the Saint."

When we turn to Castles's paper of 1790 ("Observations on the Sugar Ants," Vol. 80 of the Philos. Trans. Roy. Soc. London; abridged edit. Vol. 16, 1809, pp. 688–694), from which Schomburgk derived many of his statements, we become confused. Castles actually observed the plague in Grenada and identified the ants as "perhaps the *Formica saccharivora* of the Gmelinian edition of the *Systema Naturæ*. He describes them thus: "These ants are of the middle size, of a slender make, of a dark red colour, and remarkable for the quickness of their motions: but their greatest peculiarities were, their taste when applied to the tongue, the immensity of their number and their choice of places for their nests. All the other species of ants in Grenada have a bitter musky taste. These on the contrary, are acid in the highest degree, and when a number of them are rubbed together between the palms of the hands, they emitted a strong vitriolic sulphureous smell; so much so that when this experiment was made, a gentleman conceived that it might be owing to this quality that these insects were so unfriendly to vegetation. This criterion to distinguish them was infallible, and known to everyone. Their numbers were incredible." The first part of the description evidently applies to *F. omnivora* and not to *saccharivora*. Castles's account shows that he was quite unfamiliar with the ways of ants. He believed that they harmed the sugar-cane in some way by merely nesting about its roots and that they were destroyed by the hurricane because it tore up the cane and deluged their nests. It is the kind of account that would be written by a planter totally ignorant of entomology when suddenly confronted with a pest belonging to a group of similar but undistinguished species with very diverse habits.

Now what was the ant described by Linnæus as *Formica omnivora?* Turning to the *Systema Naturæ*, 1767, p. 581, we find a very brief description based on a specimen supposed to correspond to what Patrick Brown in his *Civil and Natural History of Jamaica*, 1756, had called *Formica domestica omnivora*, and of which he only says (p. 440): "These insects are very common in Jamaica and frequent about most of the houses; they are very voracious, and endeavour to have a part of everything that is stirring." The colour as described by Linnæus and Castles is paler than that of the ant described by Schomburgk from Barbados. Linnæus remarks, however, that he is not sure of the authenticity of his specimen (*specimen missum an genuinum?*). Neither Latreille (1802) nor Fabricius (1804) could recognize the species and merely repeated the Linnæan description. In 1893 Emery (*teste* Dalla Torre, *Catalog. Hym.* 7, p. 191) surmised that

F. omnivora might be a *Monomorium*, but in his "Myrmicinæ" in the *Genera Insect.* 1921, p. 357, he relegates it to the *species incerta sedis*. If we examine Schomburgk's description closely we cannot fail to see that the ant to which this competent naturalist attributed the devastations in Barbados was the typical blackish form of the common "fire ant," *Solenopsis geminata* Fabr. This is the only known West Indian ant to which the description and the probably more or less exaggerated accounts of the behaviour will apply. Reddish varieties of it are very common and would agree with Linnæus's and Castles's descriptions. If I am correct in this identification we shall have to change the ant's name to *Solenopsis omnivora* L., in obedience to the rules of priority in nomenclature. But this identification encounters two difficulties: first, *S. geminata* stings so painfully that we are unable to understand why this fact is not mentioned in the accounts, and second, how could this or any other ant increase to such an alarming extent on small islands? Perhaps a clue to the latter fact is furnished by such plagues as those of the Argentine ant (*Iridomyrmex humilis* Mayr), which I had occasion to observe during the summer of 1925 in the Canary Islands (Teneriffe, Gran Canaria, La Palma). Since its introduction from Madeira less than a quarter of a century ago, this ant has become an intolerable pest in the banana plantations, gardens and houses, especially in Teneriffe and Gran Canaria. It does not attack the banana plants but cultivates on their trunks innumerable mealy bugs (*Pseudococcus comstocki*) and derives its food almost exclusively from their saccharine excrement. Streams of countless thousands of ants are continually ascending and descending the trunks of the bananas, fig-trees, etc. Is it possible that a great increase of *S. geminata* during certain periods of the sixteenth and eighteenth centuries may have been brought about in the West Indies by the accidental introduction of some sugar-cane Coccid which has since been greatly reduced in numbers by Hymenopteran parasites and Coccinellids?

In this connection the following remarks in Castles's paper (p. 690) are very significant: "Mr. Smeathman, who wrote a paper on the termites, or white ants, of Africa and was at Grenada at the time, imagined that these ants were not the cause of the injury done to the canes. He supposed it was owing to the blast, a disease the canes are subject to, said to arise from a species of small flies, generated on their stems and leaves; and that the ants were attracted in such multitudes merely to feed on them. There is no doubt, that where this blast existed, it constituted part of the food of the ants; but this theory was overthrown, by observing, that by far the greater part of the injured canes had no appearance of that sort, but became sickly and withered, apparently

for want of nourishment. Besides had that been the case, the canes must have been benefited instead of being hurt by these insects." Smeathman, a very competent observer, to whom we owe one of the earliest (1781) and most admirable studies of termites, was probably on the right scent, but Castles tries to descredit his views and his recommendation (in an unquoted portion of the paragraph) to treat the cane with insecticides, because he, Castles, knew so little about the ants that he believed them to be exclusively carnivorous and to be feeding on the cane insects instead of visiting them for their honey-dew. Probably the insects that injured the cane were root-coccids, perhaps some species of *Pseudococcus*. This would explain many of the otherwise quite mysterious facts in Castles's account.

The other problematical species of ant is *F. saccharivora* and was based by Linnæus on Brown's *F. minima saccharivora* from Jamaica. This is evidently a minute house-ant and was also called the sugar ant, not because it injures the standing cane, like the preceding species, but because it feeds on stored sugar. Hughes (*Natural History of Barbados in Ten Books*, London, 1750) says it is "a small whitish ant." There can be little doubt that what he describes is *Tapinoma melanocephalum* Fabr. and that Brown's species is probably the same. But Linnæus's description seems to be drawn from a specimen even less authentic than that of *F. omnivora* and to refer to a different and larger ant (*magnitudo F. cæspitum*), with different petiolar scale, pilosity, colour, etc., in all probability *Paratrechina longicornis* Latr., which is also a common house-ant throughout the West Indies.

Edwards (*The History, Civil and Commercial, of the British Colonies in the West Indies*, 2 vols., London, J. Stockdale, 1793), however, confuses Linnæus's *F. omnivora* with his *F. saccharivora*. After describing the blast, or Aphis on sugar-cane in Jamaica as being kept down by a "wonderful little carnivorous ant," he says (Vol. II p. 220 *nota*): "It is the *Formica omnivora* of Linnæus, and is called in Jamaica the Raffles' ant, having been introduced there, as is commonly believed by one Thomas Raffles, from the Havanna, about the year 1762. But I conceive it was known in the island from the earliest times, and that it is precisely described by Sloane, as the *Formica fusca minima, antennis longissimis*. It is probably the same which, in the introduction to his first volume, he relates that the ancient Spanish inhabitants so much complained of. He says that the Spaniards deserted the part of the country where they had first settled, 'merely on account of these troublesome inmates'; declaring, 'that they frequently eat out the eyes of their young children as they lay in their cradles.' If the reader has faith enough to credit this circumstance, he

may believe some marvellous stories of the same kind, which are now-a-days related of the same insects by many venerable old gentlewomen of Jamaica." If I am right, Edwards' *F. omnivora* is Linnæus's (but not Brown's) *saccharivora* (i.e. *Paratrechina longicornis*), whereas the ants which compelled the Spaniards to desert their settlement must have been Linnæus's *omnivora* (i.e. *Solenopsis geminata*).

38. Réaumur had published studies, in which he was assisted by M. du Hamel, of a number of solitary bees in the sixth volume of the *Mémoires* (Mém. 2 to 5). The inroads of the ants are described in his account of the wall-bee (*Chalicodoma muraria*) as follows (p. 84): *Pendant qu'elle travaille à en remplir les cellules de pâtée, elle a souvent à les défendre contre des insectes friands de miel, et entr'autres, contre les fourmis. Celles-ci savent bien découvrir où il y en a. Lorsque la mouche retourne à la campagne pour y continuer ses récoltes, si une fourmi fait la découverte de l'amas de pâtée, bientôt des centaines de ses compagnes se rendent à la file pour la piller. Quelquefois, la mouche ne peut suffire a les chasser et a les tuer; elle prend le partie de leur laisser continuer leur ravage. C'est ce que M. du Hamel a observé.*

39. This is evidently Richard Bradley (died 1732), who published *The Gentleman and Gardener's Kalendar, with directions for making and ordering of Hop-grounds*, etc. 8°, 116 pp., London, 1718.

40. The caterpillars to which Réaumur alludes are probably those of the Geometrid moth *Epirrita dilutata* Hübner, which often infests elms early in the season both in Europe and in the United States.

41. The description does not permit of an identification of the spider. See also Lyonet's letter (p. 214).

42. The suggestion that ants may derive nutriment from certain substances in the soil has not, to my knowledge, appeared in the literature till recently. Stumper (Biol. Zentralbl. 38, 1918) believed that the food of the interesting little xenobiotic ant, *Formicoxenus nitidulus* Nyl., which lives in the formicaries of *Formica rufa* and *pratensis*, might consist of the rain-water filtering through the vegetable matter composing the nest of its host, but Stäger (Zeitschr. Morph. Ökol. Tiere 3, 1925) has shown that *Formicoxenus* is fed by its host in somewhat the same manner as I have described for *Leptothorax emersoni* Wheeler. Réaumur's suggestion is not absurd and might well be made the subject of an experimental investigation. It is not improbable that certain ants, especially those living in rich soil, may feed, at least to some extent and in times of scarcity, on solutions of humus.

43. As curiosities of mediæval observation and speculation I transcribe the pertinent passages from Albertus Magnus, Cardano, Aldrovandi, and Moufet. Albert the Great, Count of Bolstatten (1193–1289) in Book

8, tract 4, cap. 1 of his *De Animalibus libri XXVI* (Romæ, per Simon Nicolai de Luca 1478, fol.; and Venetiis 1519; New Ed. based on the Cologne MS. by H. Stadler, Münster i. W. Vol. 1, 1916; Vol. 2, 1920, being Vols. 15 and 16 of *Beiträge zur Geschichte des Mittelalters*), says of the ant: *Propter parvitatem autem sui capitis habet oculos sitos super quædam additamenta, quæ per modum duorum pilorum egrediuntur de capite suo: cujus signum est, quia quando illa amputantur, tunc vadit errando nesciens quo vadit, et tunc quamcumque apprehenderit aliarum formicarum, illam fortissime tenet, ut per ipsam ad casam revertatur, nec facile se ab ipsa permittet separari.* The passage is clear: the head of the ant is too small to furnish space for eyes, which are therefore placed on a couple of additions (appendages) in the form of bristles (the antennæ). Hence, when these are amputated the ant is unable to find its way and tightly holds on to any other ant it may meet in order to get back to the nest.

Cardano (*De Subtilitate Libri XXI*, Lugduni, apud Stephanum Michaelem, 1580) gives us an elaborate theory in regard to the senses of animals in general. In the following passage (p. 369) he considers the insects, especially the ant and the honey-bee: *Cum enim, ut dictum est, sensus omnes his sint imbecilles, ob generationis tempus breve, et etiam ob parvitatem, visus tamen et auditus, quoniam minus ad vitam necessarii sunt, ut infra docebimus, sunt in his omnino hebetes, adeo ut prudentissima animalium et maximæ politica, scilicet apes et formicæ, quemadmodum nuper dictum est, uno sensu ex his ex toto priventur: apes auditu, quod volantes visu indigerent, et formicæ visu, quod terrestre animal non adeo visu indigerent, cornibus auxiliantibus quæ illis loco baculi sunt ad tentandam viam, velut et limacibus: hæ enim ob siccam temperiem, illæ ob parvitate oculis privatæ, cornua pro baculo acceperunt ut cæci. Nullum autem animal volans poterat esse cæcum: nam non adeo sensim animal volare potest an impingat et excidat, si visu careat. Apibus vero cum parvæ essent et oculis indigerent, sustulit auditum, ne in tam parvo capite ambo sensus collocati fierent ob imperfectionem inutiles. Formicæ igitur cæcæ, apes vero surdæ merito fuerunt: retinent tamen forsan utræque imaginem quamdam sensus deficientis. Sed alii tres sensus, tametsi imperfecti sint, magis tamen ob vitæ necessitate vigent. Sunt autem ut dixi, gustus, odoratus et tactus.* Cardano supposes that sense-organs can co-exist in perfection only in large animals; in those as small and short-lived as insects they would necessarily be poorly developed and therefore useless if they were all present. Hence, so far as vision and audition are concerned, only one can be present, especially in such highly developed animals as ants and bees. The ants are therefore blind and use their antennæ as a blind man uses his staff, whereas flying insects, like the bees, must see though they lack hearing.

Aldrovandi (*De Animalibus Insectis Libri VII*, 1602, p. 205) after

quoting a portion of the preceding passage from Cardano, concludes: *Haec ille, quæ nunquid veritati sint consona, dubito plurimum Formicæ enim senes, alas, ut dictum est emittunt cum in juventute non viderint? Quare libentius cum Alberto Magno non parvi momenti philosopho dixerim, Formicam propter parvitatem sui capitis oculos non habere in eo, sed super quædam additamenta, quæ ceu duo peli egrediuntur in capite, nam ibi oculos esse locatos signum est, quod quando illa amputantur, tunc vadit errando, nesciens quo eat, proximam quamque apprependens et quam tenacissime amplectens, ut per ipsam ad casam suam revertatur.* Cardano would probably not have admitted the cogency of Aldrovandi's argument from the fact that ants acquire wings in their old age and could not therefore be blind in their youth, since according to his view, the wings were given to the ants by Nature as a consolation for their feebleness (*imbecillitate*) in their old age. He seems to have doubted whether the wings were ever actually used in flight (See Note 48).

Moufet (*Insectorum sive Minimorum Animalium Theatrum*, *loc. cit.*, Book II, p. 238), citing Cardano, points out in the following passage that he overlooked the fact that many flies and gnats, though much smaller than ants, nevertheless have eyes and vision, and, while agreeing that ants use their antennæ as walking-sticks, believes that they are employed primarily in testing the hardness and softness of bodies rather than in determining the path: *Cardanus visum iis primus eripere voluit, ob corporis parvitatem; parum memor multa esse muscarum et culicum generis formicis minora, quæ tamen et oculos et visum obtinuerunt. Sed si oculis capiuntur, quid lux iis prodesset non video, et cæca nocte æque atque interdiu elaborarent. Fateor equidem antennas ipsis loco baculi inservire ad viam tentandam, non quia cujusmodi sit via, non perspiciunt, sed quod mollitiem, duritiemque objectorum iis tantum mediis explorant.*

44. Réaumur uses the word "mouche" in the very general sense in which the word "fly" is used in English, as applying to all insects with transparent, membranous wings as distinguished from the Lepidoptera, Orthoptera and Coleoptera.

45. Swammerdam (1637–1685) in his well-known *Biblia Naturæ*, 2 vols., 1737–1738, regarded the large winged ants as males and supposed them to differ from the deälated females. Apart from this error and the supposition that the workers are sexless, his interpretation of the castes is correct.

46. Carl von Linnæus (1707–1778) was the first to give a more nearly correct interpretation of the castes of ants in his *Anmaerkning öfver Wisen hos Myrorne*, Vetensk. Acad. Handl. 1741, pp. 37–49. He observed that both males and females are winged and compared them respectively with

the drones and queens of the honey-bee. Réaumur seems not to have seen this work, and it is quite probable that his observations precede Linnæus's by many years. The similar observations of William Gould (*An Account of English Ants*) were not published till 1747.

47. Linnæus also observed the deälation of the winged ants in the field. Like Réaumur he supposed that the males also normally lost their wings, but Gould's observations are more accurate, as is clear from the following quotations: "If you strip a large Ant-Fly of its Wings, when a week old or more, which is very easily done, for they will come off by the most gentle Touch imaginable, and then place it in a Microscope with a Queen, you will perceive no manner of difference as to their Frame. The like indented Places, or little Hollows in the Breast where the wings commonly lie, will be observed in both; from whence there is great Reason to believe the Queen was originally adorned with such Gayety, and appeared in the Character of a Fly.

"It is also observable, as a strong Confirmation of this Sentiment, that abundance of the large Ant-Flies, just before or soon after leaving the Colonies, actually drop their Wings, and except, a small Difference in Complexion, which has not yet attained it's true Gloss, are not to be distinguished from the Queens. You may, the latter End of *July*, and great Part of *August*, often meet with these unwinged Ants travelling about as it were at Random. If you place a Number of large Ant-Flies in a Box, the Wings of many of them will, after some Time, gradually fall off like Autumnal Leaves. This Circumstance is peculiar to the large Sort; for if you confine the small ones ever so long, their Wings will continue fixed, and cannot be separated without some Difficulty. Nor is it indeed common to all the large Flies; for you may frequently observe many of them dead, and others roving with their Wings on; but they make little or no use of them in Flight: Whereas the Male can waft themselves to considerable Distances. The final Cause of this different Appearance will be considered in another Place.

"If farther we recollect the Descriptions already given of the Queens and large Ant-Flies in the several Colonies, we shall find they exceed the common Ants, and likewise one another in the same Proportion. Thus the Queens and the large Flies of the Yellow and small Black Colonies exceed the Workers as five or six to one; those of the Red Ants, not at most as two to one. Whence it is reasonable to suppose they had the same Original." Gould also observed the marked differences in colouration of female and male ants, a matter on which Réaumur is so strangely silent that one may doubt whether he had a clear conception of the male caste.

48. Cardano mentions the outgrowth of wings in old ants in his *De Rerum Varietate*, Basileæ per Sebastianum Henricpetri, 1553, p. 294: *Senes nostræ formicæ alas emittunt, sed parum volant: quod tamen a nemine ferme animadversum video.* But the passage to which Réaumur refers is in the *De Subtilitate*, Book IX, p. 368: *Formicarum genus et ipsum cum senescit alatum efficitur. Neque mirum, cum et in Phrygia scorpiones alas habeant. Et nos quandoque magno timore a scorpio alato tracti sumus, non tamen pupugit, neque mali quicquam passi sumus. Fuit autem hoc in Patavino agro juxta oppidum Saccense, anno ni fallor MDXXVII. Itaque multa talia et bombyces, ut dixi, cum formicis senescentes alas mittunt: consolatur enim illorum imbecillitate natura volatu addito. Sed ab editis alis parum supervivunt. Videtur autem formicarum genus natura non neglexisse, tum ob hanc mutationem, tum ob vitæ longitudinem, tum ob tot illarum diversa genera, et politiam etiam quam servant. Ut vero apes regnum, ita formicæ popularem statum custodiunt.* Jonston in the first chapter of the second book of his *De Insectis* says: *Alas senes, nec diu supervectura emittunt.* But he and later writers, including Réaumur, were confused, because the ants were not distinguished from the termites and because many of the references of the travellers of the sixteenth, seventeenth and eighteenth centuries are to these insects, in which both sexes are seen gradually to acquire wings and after the dispersion flight to lose them suddenly.

49. The allusion is to Bonnet's discovery (*Traité d'Insectologie*) of pædogenesis and parthenogenesis in Aphids, of which an interesting account is given by Miall (*The Early Naturalists and their Work*, 1912, p. 270, 286): "Réaumur's aphis-studies enabled him to suggest to his young friend, Charles Bonnet, the inquiry which has immortalized his name, and in the last volume of the *Histoire des Insectes* (Vol. VI, pp. 523–568) Réaumur had the satisfaction of noticing Bonnet's discoveries with warm praise. . . . Bazin of Strassburg, Trembley and Lyonet were all invited by Réaumur to repeat Bonnet's experiments, and all three got confirmatory results, as did Réaumur himself, though his trials were less complete."

50. The ants which performed the marriage-flight so beautifully described in this paragraph very probably belonged to one of the several subspecies of *Myrmica rubra* L., possibly the subspecies *scabrinodis* Nyl.

51. On account of their resemblance to moths, Réaumur called various Neuropteroid insects, including the Ephemeridæ (may-flies), *mouches papillionnacées*.

52. Réaumur believed that male and female ants, after the marriage-flight, return to the maternal nest. Occasionally the females of certain species (e.g. *F. rufa*) may thus return, but the occurrence is exceptional

and Réaumur himself later describes a marriage-flight of *Lasius emarginatus* which failed to show a return of the sexual forms to the nest (see Note 108).

53. Réaumur wrote an admirable account of the dragonflies, or demoiselles (*Mém.* VI, 1742). The peculiarities of their mating are described on pp. 420 ff. and figured on Plate 41.

54. See Note 46. Male ants do sometimes lose their wings when they are bitten off by the workers. This has been observed in some Ponerinæ (*Diacamma*) and Dorylinæ (*Eciton*). In collections the wings of *Eciton* and *Dorylus* males tend to drop off rather easily, but no European ants exhibit this peculiarity, which occurs only in certain species whose mating habits are not yet clearly understood.

55. While "adelphogamy," or mating between males and virgin females of the same formicary undoubtedly occurs occasionally in some of our common ants, and is even obligatory in certain very rare and sporadic parasitic species, like *Anergates atratulus* Schenck, there can be no doubt that mating most frequently occurs between males and females from different formicaries, owing to the simultaneous marriage-flights of many or all of the colonies of the same species over a considerable territory. The flight is obviously determined by meteorological conditions, but their precise nature has not been ascertained.

56. Deälation is not always as complete as described by Réaumur; frequently recognizable wing-stubs remain attached to the thorax of the female.

57. Réaumur's inference is probably correct, since unmated females actually tend to retain their wings much longer than those that have mated, but he did not know that the eggs remain unfertilized till they are actually being laid. Presumably the mere storing of the sperm in the spermatheca or the presence of secretions derived from the male during mating induce physiological states favourable to the deälation of the female.

58. The observations recorded in this and the following paragraph relate to termites.

59. This was the M. Charpentier de Cossigny who supplied Réaumur with valuable observations on the habits of an Ampulecid wasp which he observed in the island of Mauritius (see *Mém.* VI, pp. 279–284). According to Abbé Rozier (*loco citato*), he was a royal engineer and was nominated a correspondent of Réaumur in 1733.

60. Pierre-Louis Moreau de Maupertuis (1698–1759), an eminent mathematician and astronomer. He probably tasted the liquor described by Réaumur when, in 1736, he acted as chief of the expedition sent by

Louis XV to Lapland to measure the length of a degree of the earth's meridian. Later (1744) he became president of the Berlin Academy of Sciences at the instance of Frederick the Great. It was while he was occupying this position and quarrelling with Samuel König (one of the many who have studied the problem of the hexagonal cells of the honey-bee) that he was made the butt of Voltaire's famous diatribe, *Histoire du Docteur Akakia et du Natif de Saint Malo* (1753). Maupertuis' work has risen in importance in recent times. Not only did he discover the famous theorem of least action, but according to Whitehead (*Science and the Modern World*, 1925, p. 86), the results of his and Lagrange's investigations, "in conjunction with some subsequent mathematical methods due to two great German mathematicians of the first half of the nineteenth century, Gauss and Riemann, have recently proved themselves to be the preparatory work necessary for the new ideas which Herz and Einstein have introduced into mathematical physics. Also they inspired some of the best ideas in Clerk Maxwell's treatise."

61. There is no confirmation of Réaumur's statement that male ants have occupations very much like those of the workers. They have never been seen to participate in the labours of the colony.

62. Réaumur was not altogether clear about the male caste even as late as the summer of 1743 (see his note on *Camponotus ligniperda*, p. 205). This was due in part to his crude method of determining the sex of an ant by squeezing its gaster. The structures thus forced out of a worker might simulate the genital appendages of the male, especially under the the low magnifications which he used.

63. Like Swammerdam and Linnæus, Réaumur regarded the workers as sexless, and this view persisted for a long time. The fact that they are normally sterile females could not be ascertained till microscopic technique had made a greater advance. The English term "neuter," which embodies this erroneous conception of the worker's sex, is still occasionally used.

64. Réaumur shared the view of Swammerdam and many other writers on ants, that the meticulous care of the brood has its source in a powerful affection on the part of the workers and queens. For a different interpretation of this behaviour see my *Social Life Among the Insects*, 1923, New York, Harcourt Brace & Co., *passim*.

65. The observations here recorded are important as showing that Réaumur was the first to observe recently fecundated queens in the act of founding colonies (see also p. 207), a discovery usually attributed to William Gould. It will be noticed, however, that his observations (*An Account of English Ants*, p. 60), which I quote, were not published till

1747 and were not carried beyond the period of oviposition: "Upon frequent opening of Mole-Hills, amongst them I met with three, in each of which was a Cluster of large Female Ants, amounting to six or seven in a Cluster. They lay near the Surface, but had no regular Apartment. Upon examining and comparing them with a Queen, there was an exact Agreement in Colour, Form, and Structure. Upon dissection several of them had Parcels of Eggs in their Insides. I deposited one of the Clusters in a Box with some Earth, under which they concealed themselves, and united together, but did not work any Lodgment. Some Time after, three or four of these Females laid a few Eggs, but did not seem to take any great notice of them. For Curiosity I placed in the Box, a Cell of Workers of the same Species, and it was surprizing to observe what Fondness was expressed. The Common Ants immediately surrounded the Females, took care of the Eggs, and in a short Period made an Apartment in the Earth fit to receive them. It may also be observed that there were no Common Ants in the Hills when I found the above Clusters. In all probability they were large Ant Flies, which having been expelled their Colonies, and not falling Victims to their Adversaries, associated together in this Manner, and survived the Winter." Similar observations were published by Huber (1810), Lubbock (1876), McCook (1883) and Blochmann (1885) during the nineteenth century. Lubbock was the first to demonstrate that an isolated recently fecundated female ant (*Myrmica ruginodis*) is able to bring up her brood to maturity. The full significance of these observations was scarcely realized till the close of the past century (see Forel. Ann. Soc. Ent. Belg. 1901).

66. Leeuwenhoek (1632–1723) (Epistle of Sept. 9, 1687, in his *Arcana Naturæ*, Delphis Batavorum, Kroneveld, 1695), first discovered the eggs of ants and demonstrated that what are popularly so-called are really the pupæ.

67. The singular growth in size of the eggs of saw-flies is described in Réaumur's elaborate mémoire on these insects (*Mém.* Vol. 5, 1740, p. 127).

68. The eggs of ants are, of course, laid one by one but are brought together in packets by the workers.

69. That ant eggs increase in size after being laid has been frequently stated since Réaumur's day, but as Donisthorpe says (*British Ants*, 1915, p. 29): "This has not been proved by measurements, but from observations in artificial nests it appears to be the case." The growth may be caused by absorption through the chorion of the saliva with which the ants continually coat the eggs and which causes them to cohere in packets. Réaumur's suggestion, if tested experimentally, might yield interesting

results. Dickel has written much on the "Bespeichelung" of the honey-bee egg and seems to believe that its sexual development may be modified by the salivary substances applied by the workers and absorbed through the chorion.

70. Réaumur failed to observe that at least the older larvæ are held together in packets by the interlocking of the numerous branched or hooked hairs that cover their bodies. The cautious wording and marginal note suggest that he was not sure that the moisture was an adequate explanation.

71. This paragraph shows that Réaumur clearly recognized the two main types of colony formation, the independent and the dependent, among the social Hymenoptera, but was unable to decide which occurs among ants. It is now known that both types are represented, not only among the ants but also among the social wasps and social bees, and that the particular type adopted depends on ethological and in some cases on climatic conditions (parasitism, tropical or boreal environment, etc.). The various methods of colony formation in European ants have been recently reviewed by Eidmann (*Die Koloniegründung der einheimischen Ameisen*, Zeitschr. vergleich. Physiol. 3, 1926, p. 776–826).

72. The arguments here adduced in favour of the dependent type of colony formation among ants, though interesting, are really fallacious, because a colony-founding queen of the species of ants observed by Réaumur produces so few eggs in her first brood that she is able under normal conditions to rear them to maturity with her saliva alone.

73. The statement applies to ants in general. Réaumur may not have observed that in a few species, like the common *Formica fusca* L., the pupæ of the same colony may be either free or enclosed in cocoons.

74. According to the lexicographers, the "litron" was a sixteenth of a "boisseau," an ancient dry measure equivalent to about 13 litres, though it varied in different parts of France. According to Sée (*La France Économique et Sociale au XVIII^e Siècle*, Paris, A. Colin, 1925, p. 16), it varied in Poitou — that is, in Réaumur's own province — from 6.5 to 10 litres.

75. This might be regarded as an early experiment in phototropism.

76. After the fashion of his day, William Gould, who was evidently a hunting parson, concluded his book on English ants with a chapter on final causes, which are introduced as follows (p. 96): "The chief and most obvious Design, hitherto discovered, of the noble Insect before us, is its being intended as Sustenance for many Species of Animals, but in particular for young Pheasants and Partridges. The tender Infancy of

these Birds calls for an easy and delicious Repast, which is so happily contrived by the Disposition of Ants, as highly tends to exemplify the superior Wisdom and Beneficence of the great Creator. If we recollect the Period when their Vermicles begin to augment, their Progress, and the Metamorphoses they undergo, with several other Circumstances; and if we compare all this with the Contexture of Young Birds, and the Season when they make their Appearance, the Design will be no less conspicuous than wonderful." He then proceeds to show how each peculiarity of the ants has been specially designed to minister to the development and growth of the pheasants and partridges, and should have concluded the work with a peroration explaining how the wise and beneficent Creator had specially designed the pheasants and partridges to be shot and eaten by the hunting parsons, but he probably regarded this as self-evident.

77. Cowan (*Curious Facts*, etc., *loc. cit.*, p. 159) describes a more elaborate method of collecting the pupæ of *Formica rufa* (Penny Encyclopedia): "In 1832 we visited an old woman at Dottendorf, near Bern, who had collected for fourteen years. She went to the woods in the morning and collected in a bag the surfaces of a number of Ant-hills where the cocoons were deposited, taking Ants and all home to her cottage, near which she had a small tiled shed covering a circular area, hollowed out in the centre, with a trench full of water around it. After covering the hollow in the centre with leafy boughs of walnut or hazel, she strewed the contents of her bag on the level part of the area within the trench, when the Nurse-ants immediately seized the cocoons, and carried them *into a hollow under the boughs. The cocoons were thus brought into* one place, and after being from time to time removed, and black ones separated by a boy who spread them out on a table, and swept off what were bad with a strong feather, they were ready for market, being sold for about 4*d*. or 6*d*. a quart. Considerable quantities of these cocoons are dried for winter food of birds, and are sold in the shops."

78. The observation is recorded as follows in my copy of the *Biblia Naturæ* (German transl., Leipzig, 1752, p. 124): *Ich habe angemerkt, dass sie (die Ameisen) den Lauf der Sonne folgten, und ihre Jungen nach dem Kreise, den sie macht, vertrugen. Das sahe ich damals, als sie im Felde in einiger aufgeworfenen Erde nistelten. Sie trugen ihre Jungen allezeit auf den Fleck, der von der Sonne am meisten bestrahlt und erwärmt wurde.*

79. See Note 27.

80. This seems to be the earliest observation of the feeding of the larvæ by the workers. In 1747 Gould (*An Account of English Ants*, *loc. cit.*, p. 77) gives a more detailed description of the operation: "The Manner of

their Feeding the Worms, and Diversity of Aliment, is worth Observation. The Juices of most Sorts of Fruits and Insects, with Honey or any other delicious Liquid, are the Repast wherewith they choose to nurture them. These Juices the common Ants extract, and first convey into their own Alvus, and afterwards infuse them into the Bodies of the Vermicles. This Aliment, in all likelihood, undergoes some Refinement in the Repositories of the Ants, and being there meliorated, is properly tempered for the delicate Structure of the Worms."

81. The length of larval life varies with the feeding and temperature and the length of pupal life with the latter, but the larval period as given by Réaumur for European ants, even during the summer months, is too brief.

82. The description that follows of the spinning of the cocoon is admirable. Later writers on the ants have devoted very little attention to this behaviour.

83. Réaumur was the first to observe that in order to start its cocoon the ant-larva must be able with its labium to reach solids near its body in all three planes of space. Hence the larva, when ready to spin, is either buried in the earth by the worker nurses or covered with particles of detritus to which the silken threads can be attached. Some recent writers (O. F. Cook, Beebe) have described this behaviour as if it had never been observed before.

84. Réaumur inferred that the callow ant escapes from its cocoon by its own efforts. The discovery that the assistance of the workers is necessary, at least in the Formicine ants, is usually attributed to De Geer (*Mémoires* 2, 1771, p. 1070), but Lyonet, as shown in his letter (see p. 116), had already reached the same conclusion from similar experiments. The fact that Réaumur does not mention Lyonet, though he had preserved his letter among the notes, shows that the paragraph was written before Dec., 1743. A few years later (1747) Gould (*An Account of English Ants, loc. cit.*, p. 52, 77) also described the aid given to the emerging callows by the workers in the following quaint paragraph: "As soon as the Ant-Nymphs that are surrounded with a Tissue are tending to Life, the Workers give them the Air by an Aperture in the Head-Part of the Covering, which they open with their Saws. This Aperture they gradually enlarge, and after a Day or two take out the young Ant, and expose it to the freer Access of the Sun-Beams, which are of great Force in promoting its Maturity. They are indeed a little inconstant in the Time of dismantling these Nymphs. I have often seen them out of their Shells perfectly white, and often found them inclosed when turning yellow."

85. The Dominican Jean Baptiste du Tertre (1610–1687) wrote a *Histoire générale des iles habitées par les Français*, Paris, 1667, 4 vols., and Jean Baptiste Labat a *Nouveaux Voyages aux iles de l'Amérique*, A la Haye, P. Husson, 1724, 6 vols., new ed., 1742, Paris, C. J. B. Delaspine. The ants described in this and the two following paragraphs are large species of *Eciton* s. str (*burchelli*, *hamatum*, etc.) or *Labidus* (*prædator*), which occur only on the mainland of tropical America. None of the species has ever been taken in Martinique, and the only *Ecitons* known to occur in the Antilles are two small species of the subgenus *Acamatus* — namely, *antillarum* Forel from Grenada and *klugi* Shuckard from Grenada and St. Vincent. The latter is known only from the male and is probably co-specific with *antillarum*. If, therefore, the two priests recorded *Ecitons* from Martinique they must be in error. Such casual and itinerant observers sometimes fail to remember where they saw a particular insect and years later write of having witnessed its behaviour in countries where it does not occur.

86. Maria Sibylla Merian (1647–1717), entomologist, skilful draughts-woman and authoress of a well-known folio entitled *Dissertatio de generatione et metamorphosibus Insectorum Surinamensium*, Hagæ Comitium, apud Petrum Gosse 1726; French transl. 1730. Since she was married in 1667 we should call her "Madame," but in Réaumur's day the title "Mademoiselle" was given to all married women who did not belong to the nobility. Misled by the similarity of their size, colour and sculpture, Madame Merian confused in her account two very different ants, one of the large *Ecitons*, which are exclusively insectivorous, and one of the large *Attas*, or leaf-cutters, which cultivate and eat fungi. Hence the confusion in the paragraphs that follow (see Note 89).

87. The two terms "kakerlaque" (also written "cahcrelas" and "cancrelas," from the Dutch "kakerlak") and "ravet," employed by Réaumur, are synonymous. Both, according to Littré, refer to the American cockroach (*Periplaneta americana*).

88. Réaumur's interpretation of the forays of *Eciton* is erroneous. We now know that they are purely predatory expeditions, like those of the African *Doryli*, or driver ants, undertaken by species which have no fixed abodes.

89. Réaumur is correct in his comments on Madame Merian's figures. No ants have such an extraordinary thorax as she has depicted. Both the form and activities of the creatures shown in her Plate XVIII are obviously drawn from vague and coalescent memories of the *Ecitons* and *Attas* she had seen in Surinam.

90. That the pieces of leaves taken into the nests by the large *Attas*

were either fed to the larvæ or used for lining the galleries was the prevailing belief till Belt in 1874 gave reasons for supposing that they are used as compost on which to grow fungi as food for both the larval and adult ants.

91. This myth must have had its origin in the correct observation that the *Ecitons*, like their African cousins, the *Doryli*, bivouac in great suspended clusters, like swarms of bees, and consisting of dependent chains or nets in which the workers and soldiers form living links or meshes.

92. Réaumur gives his measurements in "toises." According to Littré, the "toise" is 1.949 meters, or six feet (our fathom).

93. Judging from the great number of ants and large quantity of brood, what Réaumur witnessed must have been the emigration of a whole *Formica pratensis* colony to a rather distant locality, and not, as he supposed, a detached swarm on its way to founding a new colony.

94. Réaumur's statement must be qualified, since it is known that swarming bees provide themselves with honey before leaving the hive. "The would-be emigrants are not, apparently, unmindful of the necessity for preparing to the utmost of their ability for the contingencies of their expedition, as every bee about to depart fills to repletion her honey-sac, by which, with economy, she will be able to supply her true stomach with food for at least a week" (Cheshire, *Bees and Beekeeping*, 1888, Vol. II, p. 126).

95. The determining factors in such migrations still remain obscure, but it is clear that they belong to the workers and not to the females.

96. Bonnet seems to have been the first to describe the transportation of ants by other members of their colony. He witnessed this behaviour first in the *Leptothorax* which he found nesting in the flower-head of a teasel (see Note 27) and later in *Formica pratensis*, but his description is inaccurate and he erroneously interpreted the behaviour as due to hostility or irritation on the part of the insects: *Maintenant, si l'on refléchit un peu sur ce fait, on sera sans doute porté à présumer avec moi, que les fourmis n'en usent ainsi les unes à l'égard des autres, que lorsqu'elles sont irritées, ou qu'une trop grande chaleur les tire de leur état naturel.. Elles se jettent alors les unes sur les autres, elles se livrent des combats singuliers, et l'un des champions saisissant l'autre sur le dessus du cou, se cramponne sur son dos, et s'obstine à ne point lâcher prise. L'autre champion, qui ne peut se debarrasser de son adversaire, est réduit à le souffrir sur ses épaules, et à le porter çà et là, pendant un temps plus ou moins long.*

97. The oft-repeated assertion that ants aid one another in carrying burdens has been tested within recent years by Cornetz (*L'illusion de*

l'entraide chez les fourmis, Revue des Idées, 1912, 12 pp.) with negative results. He says: "1° *Dans les transports d'objets par les fourmis de meses pèces [Pheidole pallidula, Cataglyphis bicolor, Aphanogaster testaceopilosa] il n'y a aucun entraide. Il n'y a pas là de fait social mais seulement c'est là des coincidences fortuites d'actions purement individuelles.* 2° *Une part très importante du travail de transport executé par les fourmis est tout à fait superflue. Non seulement les fourmis cramponnées a plusieurs autour d'objets qu'une seule fourmi peut très bien emmener à elle toute seule travaillent pour rien, mais encore elles se gênent mutuellement tres considérablement. Dans de tels cas, qui sont très frequents chez les espèces omnivores, il y a là le contraire d'une harmonie sociale. Ce que l'on a appelé 'l'esprit de la fourmilière' ne se manifeste en rien dans cette partie la plus importante de l'activité des fourmis hors de chez elle, partie de leur activité constituée par le transport d'objets.*" The matter, however, is in need of much further investigation.

98. Pliny, *Historia Naturalis* 36, 30: *Silices itinere earum adtritos videmus, et in opere semitam factam, ne quis dubitet qualibet in re quid possit quantulacumque assiduitas.*

99. Formic acid, which is, of course, the poison used by the ants in defending themselves and in attacking their enemies, is produced in considerable quantity only by the species of certain Formicine genera (*Formica, Camponotus, Lasius*, etc.). Before the last century, when the method of preparing it artificially by the oxidation of methyl alcohol and of formaldehyde was discovered, it was obtained from *Formica rufa* and *pratensis* by one of two processes: "first, by distillation; the insects are introduced into a glass retort, distilled by a gentle heat and the acid is found in the recipient; second, by the process called lixiviation; the ants are washed in cold water, spread out upon a linen cloth, and boiling water poured over them, which becomes charged with the acid part" (Cuvier, *Animal Kingdom*, Insects II, p. 489). As early as 1670, John Ray published in the Philos. Trans. Vol. 5, pp. 2063–2066, a "Letter concerning some uncommon Observations and Experiments made with an Acid Juyce to be found in Ants," and that this "acid juice" was constantly being investigated during the eighteenth century is proved by a list of papers and doctors' dissertations far too long for citation in this place. The increased interest in the substance was primarily due, of course, to its supposed medicinal properties (see Note 104).

100. The "séchoirs" to which Réaumur alludes were cages made by covering wicker frames with coarse gauze. They are described in Vol. 5 of the *Mémoires* (p. 557) and figured on Plate 35, Figs. 2 and 3. He used them for reviving and drying bees that had been drowned.

101. The peculiar odour here described is evidently produced by

"Nassonoff's glands." These organs, which have recently assumed considerable importance in connection with the intercommunication of bees as described by von Frisch ("*Ueber die 'Sprache' der Bienen*," Zool. Jahrb. Zool. u. Phys. 40, 1923–24, pp. 1–186, 2 pls.), are situated on the dorsal surface of the last abdominal segment and are ordinarily covered by the posterior portion of the preceding and overlapping tergum. The structure of the glands has been most recently described and figured by Snodgrass (*Anatomy and Physiology of the Honey-bee*, 1925, p. 114). I quote his account of their function (pp. 116, 117): "The idea that the glands of Nassonoff are scent-producing organs was proposed by Sladen (1901). Noting the peculiar pungent smell that bees give off when they are shaken from a frame of comb before the hive, Sladen identified this odour as the same as that given off from the membrane at the base of the last abdominal tergum, and, therefore, concluded that the gland cells beneath this membrane are the source of the scent of the worker honey-bee. At that time the idea was current that bees made a special buzzing sound with the wings when they found the hive entrance, or their queen temporarily lost during swarming, and that this sound, popularly known as the 'joyful hum,' served as a signal and guide to the bees. But Sladen, pointing out that bees were not known to have a sense of hearing, suggested that the sound is merely incidental to a fanning of the wings made to drive the scent away from the body, and that, not the sound, but 'the scent produced forms a means of communication between the members of a swarm or colony.'

"This view concerning the function of the glands of Nassonoff is now generally accepted, and has recently been much elaborated by von Frisch (1923), who includes the abdominal scent as one of the important elements in the 'speech' of bees. He observes that a bee gathering nectar from flowers or drinking sugar-water from a dish set out in the apiary flies about the place with the end of the abdomen protruded, and also exposes the outlets of the scent-glands while drinking. In this way she marks the position of the food source with her odour, and the other bees, told of its existence by the customary dance of the returning bee in the hive, are then able to find it for themselves in the field."

102. The slaters, or woodlice, usually called "pill-bugs," or "sow-bugs" in America, are very common slate-coloured land Crustaceans (Isopods) of the genera *Oniscus*, *Armadillidium*, etc. I have been unable to ascertain anything concerning the presence of formic acid in their bodies or concerning the malady for which they were prescribed as a remedy in France during the eighteenth century.

103. "Karabé," or "carabé," is defined as yellow amber. According

to Littré, the word is derived from the Portuguese *caraba*, which in turn is derived from the Persian *cah-rouba*, amber, from *kah*, straw, and *rabā*, to lift, attract, owing to its electric properties. The "volatile salts of karabé" are now called "succinic acid." It is interesting to note that whereas the Latin name for amber (*succinum*) is derived from *succum*, sap, the Greek ἤλεκτρον, according to Miss Grace Harriet MacCurdy (*Troy and Pæonia*, New York, Columbia Univ. Press, 1925, p. 180), is derived from the name for the sun: "The sun, *Helios Elektor Hyperion*, the Averter of Evil on high, gave his name to the bird of the sun, ἀλέκτωρ, from whose crowing all evil things take flight, and to the bright 'sun-stone,' ἤλεκτρον, which was a powerful protection against disease and ill."

104. As Réaumur says, the list of maladies supposed to be curable with formic acid is a long one. It was also supposed to be valuable as an aphrodisiac. Cowan (*loc. cit.*, p. 161) cites the following passages from James's *Medical Dictionary*: "Ants, *Formica minor* of Schroder, heat and dry, and incite to venery; their acid smell mightily refreshes the vital spirits. They are said to cure Flora, Lepra, and Lentigo. The eggs (pupæ) are effectual against deafness, and correct the hairiness of the cheeks of children being rubbed thereon." The horse-ant, *Formica major*, Schrod., "provokes to venery, and the oil thereof, by infusion, is good for the gout and palsy."

105. While most of our northern ants undoubtedly hibernate in the deeper portions of their nests, there are cases, like the blood-red slave-maker (*Formica sanguinea*), which sometimes have summer and winter nests, the former in open sunny situations, the latter in the woods, where there is less exposure to the cold and wind.

106. The measurement of the roof is omitted in the manuscript, probably because it could be easily made and inserted in the text at any time before publication.

107. The description shows that the ant is *Lasius emarginatus* Olivier, which often nests in the masonry of houses. According to Forel (*Fourmis de la Suisse*, 1st ed. 1874, 2nd ed. 1920, p. 106): *Il s'établit ainsi en immenses fourmilières dans les murs des jardins et des maisons, dans les rochers*, etc., *et trouve moyen de faire communiquer tous les vides où il loge sa couvée, soit par des passages intérieurs, soit par des chaînes des fourmis. On peut donc considérer aussi ses fourmilières comme des colonies. C'est la seule espèce de notre pays qui vive presque exclusivement de cette façon.* Wasmann (*Biol. Centralbl.* 33, 1913, pp. 264–266, 1 pl.) says: "*Ihre Nester sind meist in Felsspalten (zwischen den Platten schiefriger Gesteine), in alten Mauern, daher oft auch in Häusern, seltener unter Steinen, und am seltensten im Holze alter Bäume, wo ihre nächste*

Verwandte, 'Lasius brunneus Latr.,' haust." Forel calls attention (*loc. cit.*, p. 282) to the crepuscular marriage-flights of this ant: *L'accouplement s'effectue pendant la première moitié de la nuit.*

108. These observations, showing that the females and males do not return to the maternal colony after the marriage-flight, are undoubtedly correct and contradict those of the *Histoire* (see Note 52). I have seen marriage-flights of the subterranean *Lasius* (*Acanthomyops*) *claviger* Roger in the United States very similar to the one described by Réaumur for *L. emarginatus*. They also occur in the late summer, but on sunny days when the air is rather still. After the dark-coloured sexual forms have departed the pale yellow, myopic workers withdraw into their subterranean galleries and are not seen again at the surface till the next marriage-flight the following year.

109. The passage is very interesting as showing Réaumur's recurrent preoccupation with the problem of colony-formation, although we should have expected his knowledge of the honey-bee to have prevented him from regarding the marriage-flights of single couples of ants as so many swarms reduced to their lowest terms. This, of course, leaves the fate of the workers unsolved, as we see from the subsequent questions.

110. The ant is evidently *Formica pratensis*, which he had formerly called the ant of the formicaries made of particles of wood (*à brins de bois*).

111. Very similar parasitic mites were later observed by De Geer (*Mémoires* II, 1771, p. 1075, Pl. 42, Fig. 4) on virgin queens of *Formica rufa* L., and as early as 1668 by Redi (*Esperienze intorno alla generazione degli Insetti:* Firenze, Insegna della Stella) on both winged and worker ants.

112. *Theologie des Insectes ou demonstration des perfections de Dieu dans tout ce qui concerne les Insectes*, A la Haye, Swart. 1742, 2 vols. This was a translation of Friedrich Christian Lesser's *Insecto-Theologia, oder: Vernunft-und schriftmässiger Versuch, wie ein Mensch durch aufmerksame Betrachtung derer sonst wenig geachteten Insekten zu lebendiger Erkenntniss und Bewunderung der Allmacht*, etc., *des grossen Gottes gelangen könne*, Frankfurt u. Leipzig, Blochberger, 1738. There were three German editions of the work, three French editions (see Note 161), an Italian and an English translation of Lyonet's translation. It would be interesting to investigate the influence on the development and progress of entomology of the constant insistence of such works during the eighteenth and early nineteenth centuries on the insects as marvellous proofs of God's wisdom and ingenuity. These organisms by stimulating the sermonizing and exhortatory proclivities of the theological mind may have been freed to

an appreciable degree from the contempt and neglect with which for many centuries they had been treated by the great mass of mankind.

113. The ants probably belonged to some species of *Lasius*. The French name of the hollyhock (*Althaa rosea*) is now written "rose tremière."

114. The size and colour of the workers, the great volume of the sexual larvæ and the nesting habits as described by Réaumur show that the ant was the common *Tetramorium cæspitum* L.

115. "Acting differently according to circumstances" is intelligence, as we should define the term at the present time.

116. The larvæ of *Tetramorium cæspitum* are furnished with characteristic hooked and bifurcated hairs (see Wheeler, *Observations on Some European Ants*, Journ. N.Y. Ent. Soc. 17, 1907, Fig. 2, p. 182), and it is these, and not exclusively the sticky coating noticed by Réaumur, that hold them together in packets (see Note 70).

117. These observations also refer to *Tetramorium cæspitum*.

118. The sinking by the workers of numerous pits in the earth in order to reach larvæ or pupæ buried by the caving-in or obliteration of the galleries may be readily observed. The workers are undoubtedly guided to the individual larvæ or pupæ by their peculiar odour, much as trained pigs and dogs are guided to truffles.

119. Réaumur was on the verge of a subject which in the following century led to the elucidation of the compound nests and mixed colonies of ants and of the interesting phenomena of social parasitism, slavery, etc.

120. Here Réaumur seems to have decided to attack the problem of the founding of colonies by controlled experiment.

121. The large ants described in this place are *Camponotus herculeanus* L. subsp. *ligniperda* Latreille. The note shows clearly that the *Histoire de Fourmis* was written before June 1743, since Réaumur, while writing that essay, regarded *Formica pratensis* as the largest European ant.

122. Réaumur did not see the males of *C. ligniperda*. What he here takes to be males are the minor workers. He corrects himself in a subsequent paragraph.

123. Réaumur undoubtedly had before him a recently fecundated queen of *C. ligniperda* which had established her nest in an abandoned Lepidopteran cocoon but had not yet oviposited. The case is precisely like those so often encountered in North America where the queens of a variety of *ligniperda*, viz. *noveboracensis* Fitch and of the allied subsp. *pennsylvanicus* De Geer, start their colonies in the abandoned pupal cells of a longicorn beetle (*Rhagium lineatum*) under the bark of pine logs (see

my *Ants, their Structure*, etc., 1910, Fig. 105, p. 189). The nest-founding behaviour of our North American forms of *C. herculeanus* was first described by McCook (*How a Carpenter Ant founds a Colony*. Proc. Acad. Nat. Sci. Phila. 1883, p. 303–307).

124. The error of supposing that the queen *Camponotus* must die after laying her eggs is natural. Réaumur would have found it difficult to conceive that she actually possesses the extraordinary ability to go without food for some eight months while she is producing and rearing her first brood of workers.

125. The very large size of the nests and the more greyish and less blackish colour of the workers seem to indicate that Réaumur's new species was the true *Formica rufa* L.

126. The work to which Réaumur refers is by Wilhelm Piso, physician to the Prince of Nassau, with whom he traveled in Brazil. It is entitled *De Indiæ utriusque re naturali et medica libri XIV*, Amstelodami, Elzevir 1658, fol. pp. 327. The insects described by Piso as "cupia" are not ants, however, but termites, and his account of their acquiring and then losing their wings (*certo tempore alas acquirunt easque postea rursus deponunt*) is correct.

127. George Marcgraf (1610–1644), naturalist, traveller and author of an important folio: *Historia rerum naturalium Brasiliæ, Libri VIII*, De Laet, Amsterdam, 1648. The seventh book treats of the insects, including the "cupia," or termite.

128. The reference is to Carl Rayger (1641–1707), *De formicis volantibus*, Ephem. Acad. Nat. Curios. dec. 3, ann. 2, 1694, pp. 27–29. I have corrected the reference in the first sentence, from which the name of Rayger seems to have been omitted.

129. Jacob Bontius (or Jacob de Bondt), physician to the East India Company, who died in 1631. I have not seen his work "'*Historia naturalis et medicæ Indiæ orientalis libri VI,' a Gul. Pisone in ordinem redacti, atque additionibus rerum et iconum adaucti*," Amsterdam, 1658, but only a translation into English "by a Physician" and entitled *An Account of Diseases, Natural History and Medicines of the East Indies*, London, T. Noteman, 1769. On p. 179 there is the following remark on lac: "The Author here speaks of the ants which elaborate the lack. I have only to add that these ants have wings, are of a purple colour, and that they fly about among the flowers, herbs, shrubs, and trees, like the bees, collecting materials for their manufacture. The ants which have no wings, do not elaborate the lack." The fact that the lakshà, or lac-insects (*Carteria lacca*), like many other Coccids, are attended by ants (see Note 32) gave rise to the myth that they made the lac from the resinous juices of certain plants. This

myth seems to have been believed by one of the earliest writers on the substance, Amatus Lusitanicus (Giovanni Rodriguez da Castello Bianco), professor of medicine in Ferrara about the middle of the sixteenth century and author of a treatise on phthiriasis (1556). The making of lac by the ants is described by Cardano (*De Subtilitate*, book 9) as follows: "'*Laccam' in Orientali India conficere certissimum. In regno Pegu cum terra pluvia, vel aqua justo plus irrigatur, ligna tenuia ab incolis disposita conscendunt (formicæ). Ex illis certa gummi species defluit, quod illæ exsugunt et circa ramos, ut Apes mel ac ceram diffundunt.*" The story is also repeated by Réaumur at the very beginning of the first volume of the *Mémoires*, 1734, p. 5: *La Lacque, si commode pour la Cire à cacheter, d'un si grand usage pour les Vernis, et dont on tire une teinture rouge pour les Marroquins, n'est-elle pas dûë aussi à des espèces des Fourmis ailées? Les soins qu'on a dans le Royaume de Pégu, de ficher en terre une infinité de petits bâtons qui les invitent à venir s'y arrêter, et à y déposer leur gomme résineuse, donnent la facilité d'en faire des amas considérables.* The true origin of lac seems not to have been known to Europeans till William Roxburgh published his account of the insect in Trans. Soc. Bengal 2, 1790, pp. 361–364, and Phil. Trans. 81, 1791, pp. 228–235. Much later another naturalist who had studied the insect in India, H. J. Carter, described it in Ann. Mag. Nat. Hist. (3) 7, 1861, pp. 1–10. The words "Acta Ph. Eph. 1730 p. 304" at the end of Réaumur's note refer to some article on formic acid. I have not been able to trace this reference.

130. See also Réaumur's note p. 213. In the following paragraph, Forel (*Fourmis de la Suisse*, 2nd ed., 1920, p. 307) seems to attribute to Pierre Huber (1814) the discovery of the opening and closing of the nest-entrances by the workers: "*Huber a montré que les 'F. rufa' et 'pratensis' savaient fermer et ouvrir les portes de leurs nids. Ce fait a été souvent observé des lors. Toutes les fourmis savent faire celà, mais chaque espèce emploie les matériaux qui lui sont propre. Ce n'est pas particulièrement le soir et le matin que les 'F. rufa' ferment et ouvrent les entrées de leur nid; on peut dire en thèse générale que les fourmis quelles qu'elles soient ne conservent des ouvertures à leur demeure que pendant qu'elles les utilisent, et qu'à tout autre moment elles les ferment plus ou moins complètement. Ainsi les 'S. fugax' et les 'L. flavus' ont à l'ordinaire des nids entièrement fermés, ou peu s'en faut, mais au moment du depart des ♀ et des ♂ le dôme s'ouvre de tout part; les ☿ y font aussi des trous depuis dedans lorsqu'elles veulent bâtir un nouvel étage. Elles ferment ensuite les portes avec des grains de terre. Les 'F. rufa' barricadent leurs entrées avec des poutres (tiges des graminées, etc.); elles ferment en temps de pluie et lorsqu'il fait froid; une ☿ garde ensuite a l'ordinaire chacune des portes en restant près de la sortie.*"

131. The ant of which Leeuwenhoek (*Arcana Naturæ, loc. cit.*) described the sting was probably *Myrmica lævinodis* Nyl.

132. What Réaumur saw were probably small workers. He still remains in doubt about the male caste.

133. The dates of this and the following paragraph show that Réaumur had been seriously observing the ants for nearly a decade.

134. These "fleshy horns," which seemed to Réaumur worthy of note, were probably portions of the extruded viscera.

135. Obviously the abdominal petiole, which in *Formica pratensis* is scale- or palette-shaped.

136. Réaumur seems to have mistaken the orifice of the epinotal gland for one of the stigmata, or spiracles. There are only two pairs of spiracles, not four pairs, anterior to the epinotum, which is really the first abdominal segment.

137. See Note 9.

138. This seems to be the first description of the method of mutual feeding among ants.

139. Since it is very easy to distinguish the deälated females of *Formica pratensis* from the workers without performing the experiment suggested by Réaumur, we may suppose that this note was written when he first began to study the ants, possibly in 1734 or 1735.

140. The list is interesting as indicating at least a part of the figures, which Réaumur had planned for the plates of the seventh volume of the *Mémoires*.

141. In the transcription of the original manuscript the date is given as 1792, but this must be an error of the typist. Réaumur died in 1757.

142. Although Antonio Vallisnieri (1661–1730) was a rather prolific writer on insects, his works are now rare in libraries. I have his *Dialoghi fra Malpighi e Plinio intorno la curiosa origine de molti insetti*, published in 1700, and his *Esperienze ed Osservazioni intorno all' Origine, Sviluppi, e Costumi di varii Insetti, con altre spettanti alla Naturale, e Medica Storia*, 2nd ed. (first ed. 1713), but they contain nothing of interest on the ants. Perhaps Réaumur refers to the three volumes edited by Vallisnieri's son and published at Venice in 1733 under the title *Opere fisico-mediche continenti un gran numero di trattati, osservazioni, ragionamenti e dissertazioni sopra la fisica, la medicina e la storia naturale.* I have not been able to consult this work.

143. The "Worton" in the manuscript is evidently a misspelling for Wotton (known also as Odonudus), of whom Miall (*Early Naturalists, loc. cit.*, p. 49) says: "Less known to fame was Edward Wotton (1492–1555), a London physician, who published a Latin treatise *De differentiis*

animalium (fol. Paris 1552) nearly at the same time with Gesner's History. Wotton methodized the zoology of Aristotle, and drew up the first formal classification. His book is sagacious and careful, but dry. It was little read, and exerted no appreciable influence upon the progress of Zoology."

144. The reference is, perhaps, to Linnæus's paper of 1741 (see Note 17), which Réaumur had not seen when he was writing the *Histoire des Fourmis*.

145. In all probability the physician Henry Power, who died in 1673 and who wrote: "Insects as Objects of Microscopical Investigation" in Power's *Experimental Philosophy*, 1664, 4°, pp. 1–83.

146. This note is unintelligible unless it refers to some apparatus (trap) for killing ants while they are moving to and from the nest.

147. Probably a reference to Oviedo's and Herrera's account of the ant plague in Santo Domingo (see Note 37).

148. While the described arrangement might enable one to ascertain the predilections of various species of ants for particular foods, it is not so easy to see how it would yield very satisfactory results in the investigation of their powers of communication. The setting up of the unfurnished table at a similar distance from the formicary would seem to imply that the ants were supposed to choose by sight. The great reliance of these insects on the topochemical properties of their trails to and from the nest was apparently unknown to Réaumur. Gould (1747 p. 90) actually performed an experiment on choice of foods by the ants very similar to the one proposed by the French observer.

149. See Note 17.

150. An early instance of the use of litmus paper as an indicator for the detection of free acid.

151. A small amount of formic acid might be readily obtained by placing a bell-jar over ants (*Formica rufa*, *pratensis* and allied American species) which have been sufficiently irritated to discharge the substance as a fine spray. This spraying habit which is responsible for the vulgar name "pismire" and which must have been well known to Réaumur, is not described in the manuscript, which breaks off where we should expect the matter to be introduced.

152. These notes, which were either to form part of the conclusion of the *Histoire* or a separate *mémoire*, are of interest in connection with the still unwritten history of insecticides.

153. Hans Sloane (1660–1752), first body physician of George I and one of the founders of the British Museum. Réaumur refers to his *A Voyage to the Islands Madera, Barbados, Nieves, St. Christophers and Jamaica,*

with the Natural History of the Herbs and Trees, Four-footed Beasts, Fishes, Birds, Insects, Reptiles, etc. London (author), 2 vols. fol., 1705 and 1725. The figure on Pl. 238, which Réaumur may have decided to reproduce in the seventh volume of the *Mémoires*, undoubtedly represents a large arboreal nest of the common *Eutermes pilifrons* of Jamaica, although Sloane attributes it to an ant which he calls *Formica maxima nigra alata* and synonymizes with a number of other forms from tropical America vaguely described by earlier authors. I know of no Jamaican ant that answers the description, but the winged sexes of *Eutermes* are large and dark-coloured and were probably mistaken for ants by Sloane.

154. Lyonet (1707–1789), cipher-secretary and confidential translator of the United Provinces of Holland, skilful draughtsman and insect anatomist, is justly celebrated for his work on the goat-moth caterpillar (*Traité Anatomique de la Chenille qui ronge le bois du Saule*, A la Haye (the author), 1762). This is "perhaps the most laborious and beautiful example of minute anatomy which has ever been executed. All the details of structure are given with extraordinary fidelity. The dissection of the head of a caterpillar is a feat which will never be surpassed" (Miall). I have already alluded (Note 112) to his translation of Lesser's *Insecto-Theologia*, to which he made many additions. He produced also two volumes with 54 plates entitled *Recherches sur l'Anatomie et les métamorphoses de différentes espèces d'insectes*, which were published in 1832, long after his death by W. de Haan (Paris, Roret), and also made the exquisite drawings for the plates of Trembley's famous *Mémoires pour servir à l'Histoire d'un Genre de Polypes d'Eau Douce*, Leyden, Verbeck, 1744.

155. This is perhaps the spider to which Réaumur refers (see Note 41).

156. The paragraph is interesting because it indicates the contents of the seventh volume of the *Mémoires*. That this volume would begin with the ants and conclude with the beetles is apparent from an examination of the six published volumes. The ants as social "flies" would naturally follow immediately after the bees (*mouches à miel*), wasps and ichneumons, which were described in the sixth volume. Apparently the delay in obtaining a sufficient grasp of the Formicidæ by 1742, however, led Réaumur to close this volume with miscellaneous "Mémoires" on several very different "flies," namely the ant-lions, dragonflies, may-flies, Pupipara, and with supplementary observations on the Aphids.

157. Lyonet uses the word "fly" in the same sense as Réaumur. See the preceding note and Note 44.

158. See Note 22. Lyonet regarded the process of binding the granules of earth together with a secretion as "spinning." Since the secretion

in this case is not silk but a glutinous liquid derived not from the sericteries, or labial glands, but from the maxillary glands, we should not call it spinning or compare it with the silk production of caterpillars. But inasmuch as there are insects and other Arthropods that produce silk-like threads from other glands (fore metatarsal glands of Embiids, Malpighian vessels of Myrmeleonids and Curculionids, spinnerets of Spiders, etc.), and since the sericteries of insects are really modified salivary glands, any definition of the concept of spinning must be arbitrary.

159. These are, apparently, the earliest rudimentary experiments in determining whether ants of different colonies but of the same species will tolerate one another. It would seem that the strange ant was sometimes adopted, but since Lyonet was not sure of the identity of the victorious individuals, his experiments are inconclusive.

160. See Note 84.

161. The incident to which Lyonet alludes in this paragraph may be inferred. Réaumur had asked the publisher Durand to issue a second edition of Lyonet's translation of Lesser's *Theologie des Insectes*, and Durand had agreed to do so, but had announced that he could not legally send copies of the volume to Holland. This seems to have offended Lyonet, who declined to make any additions or corrections to the work. We find that the second edition was, in fact, published by Chaubert and Durand in Paris in 1745, that is, two years later than Lyonet's letter to Réaumur. A third edition was published in 1747 at the Hague, where the first edition had appeared in 1742.

162. Owing to the peculiar difficulty to which Lyonet calls attention, it has taken much longer to acquire a knowledge of the life-histories of the Coleoptera in general than of some of the other large orders of insects such as the Lepidoptera, Diptera and Hymenoptera.

A LIST OF RÉAUMUR'S WORKS.[1]

(1) 1708 (1730) *Observations sur la manière dont un petit coquillages appellé en latin "trochas," perce la coquille d'une moule pur succer la moule.*
Histoire, 1708 (1730), p. 28–29.

(2) 1708 (1730) *Manière générale de trouver une infinité de lignes courbes nouvelles, en faisant parcourir une ligne quelconque donnée, par une des extremités d'une ligne droite donnée aussi, et toûjours placée sur un même point fixe.*
Mémoires, 1708 (1730), p. 197–211; *Histoire*, p. 82–84.

(3) 1709 (1733) *Methode générale pour déterminer le point d'intersection de deux lignes droites, infiniment proches, qui rencontrent une courbe quelconque vers le même côté, sous des angles égaux moindres, ou plus grands qu'un droit; et pour connoître la nature de la courbe décrite par une infinité de tels points d'intersection.*
Mémoires, 1709 (1733), p. 149–162, 1 pl.; *Histoire*, p. 64–68 (*Sur une espèce imparfaite de dévelopées*).

(4) 1709 (1733) *Formules générales pour déterminer le point d'intersection de deux lignes droites infiniment proches, qui rencontrent une courbe quelconque vers le même côté, sous des angles égaux.*
Mémoires, 1709 (1733), p. 185–192, 4 figs.; *Histoire*, p. 64–68 (*Sur une espèce imparfaite de dévelopées*).

[1] This bibliographical list, arranged in chronological order, has been compiled from numerous sources, mainly from the files of the *Histoire* and *Mémoires* of the Académie Royale des Sciences of Paris, in which most of the articles were either published or reviewed. After my bibliography had been collected, I found that the work had been done already by Abbé Rozier in the fourth volume of his *Nouvelle Table des Articles contenus dans les Volumes de l'Académie Royale des Sciences de Paris, depuis 1666 jusqu'en 1770, dans ceux des Arts et Métiers publiés par cette Académie, et dans la Collection Académique*, 4 vols. 4°, 1775–1776 (Paris, Ruault). Usually there is in the *Histoire* an abstract or summary of the complete article published in the *Mémoires* of the same volume, but the title is abbreviated or modified. When articles appear only in the *Histoire* they are either brief notes or longer abstracts like those published in the "proceedings" of many other learned societies. Many of Réaumur's articles were reviewed in contemporary scientfic journals, and several were translated into other languages. I have cited the translations to which I have seen references, but not the reviews. The dates in parentheses are those of the publication of the volumes of the *Histoire* and *Mémoires*.

(5) 1709 (1733) *De la formation et de l'accroissement des coquilles des an maux, tant terrestres qu'aquatiques, soit de mer, soit rivière.*
Mémoires, 1709 (1733), p. 364–400, 2 pls.; *Histoire*, p. 17 21 (*Sur la formation des coquilles*).

(6) 1710 (1712) *Insecte de limaçons.*
Mémoires, 1710 (1712), p. 305–310, 1 pl.

(7) 1710 (1712) *Examen de la soye des araignées.*
Mémoires, 1710 (1712), p. 386–408.

(8) 1710 (1712) *Du mouvement progressif, et de quelques autres mouveme de divers espèces de coquillages, orties et étoiles de mer.*
Mémoires, 1710 (1712), p. 439–490, 4 pls.; *Histoire*, p. 10 13 (*Sur le mouvement progressif de plusieurs espèces coquillages*).

(9) 1711 (1730) *Expériences pour connoistre si la force des cordes surpasse somme des forces de fils qui composent ces mesmes corde.*
Mémoires, 1711 (1730), p. 6–16; *Histoire*, p. 82–84 (*S la force des cordes*).

(10) 1711 (1730) *Des différentes manières dont plusieurs espèces d'anima de mer s'attachent au sable, aux pierres, et les uns a autres.*
Mémoires, 1711 (1730), p. 108–134, 2 pls.; *Histoir* p. 7–9 (*Sur la manière dont plusieurs espèces de coquillag s'attachent a certains corps*).

(11) 1711 (1730) *Découverte d'une nouvelle teinture de pourpre, et divers expériences pour la comparer avec celle que les ancie tiroient de quelques espèces de coquillages que nous trouvo sur nos côtes de l'Océan.*
Mémoires, 1711 (1730), p. 166–196, 1 pl.; *Histoire*, p. 11 14 (*Sur une nouvelle pourpre*). Reprinted with introdu tion in A. Dedekind, *Ein Beitrag zur Purpurkund* Vol. 2. pp. 39–168, Berlin, 1906.

(12) 1711 (1730) *Description des fleurs et des graines de divers Fucus, et que ques autres observations physiques sur ces mêmes plante*
Mémoires, 1711 (1730), p. 282–301, 3 pls.; *Histoire*, p. 54 56 (*Sur les fleurs et les graines de quelques espèces de Fucus*

(13) 1712 (1731) *Suite d'un mémoire imprimé en* 1711, p. 282 *sur les fleu et les graines de diverses plantes marines.*
Mémoires, 1712 (1731), p. 21–44, 5 pls.; *Histoire*, p. 48 49 (*Sur les fleurs et les graines de Fucus*).

(14) 1712 (1731) *Observations sur le mouvement progressif de quelques c*

quillages de mer, sur celuy des hérissons de mer, et sur celuy d'une espèce d'étoile.

Mémoires, 1712 (1731), p. 115–145, 3 pls.; *Histoire*, p. 12–16 (*Sur le mouvement progressif de quelques coquillages ou animaux de mer*).

(15) 1712 (1731) *Sur les diverses reproductions qui se font dans les écrevisses, les omars, les crabes, etc.; et entr'autres sur celles de leurs jambes et leurs écailles.*

Mémoires, 1712 (1731), p. 223–241, 1 pl.; *Histoire*, p. 34–35 (*Sur la reproduction de quelques parties des écrevisses*).

(16) 1713 (1739) *Observations sur des prunes sauvages, monstrueuses par leur formes.*

Histoire, 1713 (1739), p. 43–44 (*Observation botanique*).

(17) 1713 (1739) *Boletus ramosus, coraloides foetidus, Morille branchuë de figure et de couleur de corail, et très-puante.*

Mémoires, 1713 (1739), p. 69–74, 1 pl.

(18) 1713 (1739) *Expériences et reflexions sur la prodigieuse ductilité de diverses matières.*

Mémoires, 1713 (1739), p. 199–220, 1 pl.; *Histoire*, p. 9–12 (*Sur la ductilité de quelques matières*).

(19) 1713 (1739) *Description d'une machine portative, propre à soutenir des verres de très-grands foyers, présentée à l'Académie par M. Bianchini.*

Mémoires, 1713 (1739), p. 299–306, 1 pl.

(20) 1714 (1741) *Expériences pour sçavoir si le papier et quelques autres corps sont capable d'arrêter l'air et l'eau; et si quand ils arrêtent l'un de ces liquides, ils arrêtent l'autre.*

Mémoires, 1714 (1741), p. 55–64; *Histoire*, p. 1–4 (*Sur le passage de l'air et de l'eau au travers de certaines corps*).

(21) 1714 (1741) *Observations sur une petite espèce de vers aquatique assez singulière.*

Mémoires, 1714 (1741), p. 203–208.

(22) 1714 (1741) *Des effets que produit le poisson appellé en françois torpille, ou tremble, sur ceux qui le touchent; et de la cause dont ils dependent.*

Mémoires, 1714 (1741), p. 344–360, 2 pls.; *Histoire*, p. 19–22 (*Sur le tremble, ou la torpille*).

(23) 1715 (1741) *Observation sur l'accouplement du lièvre ou chat marin.*

Histoire, 1715 (1741), p. 11.

(24) 1715 (1741) *Observations sur les mines de turquoises du Royaume; sur*

la nature de la matière qu'on y trouve, et sur la manière dont on lui donne la couleur.

Mémoires, 1715 (1741), p. 174–202, 2 pls.; *Histoire*, p. 1–3 (*Sur les turquoises*).

(25) 1716 (1718) *Observations sur la matière qui colore les perles fausses, et sur quelques autres matières animales d'une semblable couleur; à l'occasion de quoi on essaye d'expliquer la formation des écailles des poissons.*

Mémoires, 1716 (1718), p. 229–244; *Histoire*, p. 18–21 (*Sur les écailles des poissons*).

(26) 1716 (1718) *Eclaircissements de quelques difficultés sur la formation et l'accroissement des coquilles.*

Mémoires, 1716 (1718), p. 303–311; *Histoire*, p. 21–24 (*Sur la formation des coquilles*).

(27) 1717 (1719) *Observations sur le coquillage appellé pinne marine, ou nacre de perle; à l'occasion duquel on explique la formation des perles.*

Mémoires, 1717 (1719), p. 177–194, 2 pls.; *Histoire*, p. 26–27 (*Sur la formation de perles*).

(28) 1718 (1741) *Essais de l'histoire des rivières et des ruisseaux du Royaume qui roulent des paillettes d'or; avec des observations sur la manière dont on ramasse ces paillettes, sur leur figure, sur le sable avec lequel elles sont mêlées, et sur leur titre.*

Mémoires, 1718 (1741), p. 68–88.

(29) 1718 (1741) *Description d'une mine de fer du pays de Foix; avec quelques reflexions sur la manière dont elle a été formée.*

Mémoires, 1718 (1741), p. 139–142; *Histoire*, p. 6–7 (*Sur une mine de fer singulière*).

(30) 1718 (1741) *Additions aux observations sur la mue des écrevisses, données dans les Mémoires de 1712.*

Mémoires, 1718 (1741), p. 263–274, 1 pl.; *Histoire*, p. 22–24 (*Sur la muë des écrevisses*).

(31) 1719 (1721) *Histoire des guespes.*

Mémoires, 1719 (1721), p. 230–277, 7 pls.; *Histoire*, p. 13–20 (*Sur les guespes*). German translation by J. Riem, Dresden. 1789, 8°.

(32) 1720 (1722) *Remarques sur les coquilles fossiles de quelques cantons de la Touraine, et sur les utilités qu'on en tire.*

Mémoires, 1720 (1722), p. 400–416; *Histoire*, p. 5–9 (*Sur des coquilles fossiles de Touraine*).

(33) 1721 (1723) *Moyen de mettre les carrosses et les brélines en état de passer*

par des chemins plus étroits que les chemins ordinaires, et de se tirer plus aisément des ornières profondes.
Mémoires, 1721 (1723), p. 224–230, 1 pl.

(34) 1721 (1723) *Sur la nature et la formation des cailloux.*
Mémoires, 1721 (1723), p. 255–276, 2 pls.; *Histoire*, p. 12–16 (*Sur la formation des cailloux*).

(35) 1721 (1723) *Reflexions sur l'état des bois du Royaume; et sur les précautions qu'on pourroit prendre pour en empêcher le dépérissement, et les mettre en valeur.*
Mémoires, 1721 (1723), p. 284–301.

(36) 1722 *L'art de convertir le fer forgé en acier, et l'art d'adoucir le fer fondu, ou de faire des ouvrages de fer fondu, aussi finis que de fer forgé.*
Paris, Brunet, 1722, 1 vol. 4°; *Histoire*, 1722 (1724), p. 39–55 (*précis*); reprinted in part, with resumé by F. Cournot, in Revue de Métallurgie, 19, 1922, p. 447–468, 14 figs., 1 pl.

(37) 1722 (1724) *Observations sur la végétation du nostoch.*
Mémoires, 1722 (1724), p. 121–128; *Histoire*, p. 56–58 (*Sur le nostoch*).

(38) 1722 (1724) *Reflexions sur les expériences d'une nouvelle manière d'éteindre le feu, qui furent faites à l'Hôtel Royale des Invalides le jeudi 10. Décembre 1722.*
Mémoires, 1722 (1724), p. 143–155; *Histoire*, p. 5–7 (*Sur un secret pour éteindre le feu dans les incendies*).

(39) 1723 (1725) *Examen d'une matière cuivreuse, qui est une espèce de verd-de-gris naturel.*
Mémoires, 1723 (1725), p. 12–20, 1 pl.; *Histoire*, p. 36–37 (*Sur un verd-de-gris naturel*).

(40) 1723 (1725) *Expériences qui montrent avec quelle facilité le fer et l'acier s'aimantent, même sans toucher l'aimant.*
Mémoires, 1723 (1725), p. 81–105; *Histoire*, p. 1–7 (*Sur la manière dont le fer s'aimante*).

(41) 1723 (1725) *Des merveilles des dails, ou de la lumière qu'ils répandent.*
Mémoires, 1723 (1725), p. 198–204; *Histoire*, p. 8–9 (*Sur la lumière des dails*).

(42) 1723 (1725) *Sur la rondeur que sembent affecter certaines espèces de pierres, et entr'autres sur celle qu'affectent les cailloux.*
Mémoires, 1723 (1725), p. 273–284; *Histoire*, p. 9–13 (*Sur la rondeur des pierres et des cailloux*).

(43) 1724 (1726) *Sur des coquilles nommées balanus et pinnes-marines, attachées contre le bois d'un vaisseau.*
Histoire, 1724 (1726), p. 35.

(44) 1724 (1726) *De l'arrangement que prennent les partis des matières metalliques et minérales, lorsqu'après avoir été mises en fusion, elles viennent à se figer.*
Mémoires, 1724 (1726), p. 307–316, 1 pl.

(45) 1724 (1726) *Moyen de conserver les essieux des roues de voiture dans toute leur force; d'épargner la façon de les recharger en leur donnant des espèces d'emboîtures qui coutent peu.*
Mémoires, 1724 (1726), p. 360–365, 1 pl.

(46) 1725 (1727) *Principes de l'art de faire le fer blanc.*
Mémoires, 1725 (1727), p. 102–130; *Histoire*, p. 29–33 (*Sur l'art de faire le fer blanc*).

(47) 1725 (1727) *Extrait de divers mémoires de M. Sarrazin, medecin du Roy à Quebec, et correspondant de l'Académie sur le rat musqué.*
Mémoires, 1725 (1727), p. 323–345, 4 pls.

(48) 1726 (1728) *Sur le son que rend le plomb en quelques circonstances.*
Mémoires, 1726 (1728), p. 243–248; *Histoire*, p. 1–3 (*Sur le plomb sonnant*).

(49) 1726 (1728) *Que le fer est de tous les métaux celui qui se moule le plus parfaitement, et quelle en est la cause.*
Mémoires, 1726 (1728), p. 273–287; *Histoire*, p. 7–10 (*Sur une propriété singulière du fer*).

(50) 1726 (1728) *Remarques sur la plante appellée à la Chine Hia Tsao Tom Tchom, ou plante ver.*
Mémoires, 1726 (1728), p. 302–305, 1 pl.

(51) 1727 (1729) *Idée générale des différentes manières dont on peut faire la porcelaine; et quelles sont les véritables matières de celle de la Chine.*
Mémoires, 1727 (1729), p. 185–203.

(52) 1727 (1729) *Observations sur la formation du corail, et des autres productions appellées plantes pierreuses.*
Mémoires, 1727 (1729), p. 269–281; *Histoire*, p. 37–39 (*Sur le corail*).

(53) 1727 (1729) *Observations sur le porc-épic; extraites de mémoires et de lettres de M. Sarrazin, médicin du Roy à Quebec, et correspondant de l'Académie.*
Mémoires, 1727 (1729), p. 383–395.

(54) 1728 (1730) *Histoire de teignes ou des insectes qui rongent les laines et les pelleteries. Première Partie.*

Mémoires, 1728 (1730), p. 139–158, 2 pls. German translation in Hannöv. Gelehrt. Anzeig. 1754, Stück 58–60, p. 811–851, 1 pl.

(55) 1728 (1730) *Suite de l'histoire des teignes ou des insectes qui rongent les laines et les pelleteries. Seconde Partie. Où l'on cherche principalement les moyens de deffendre les étoffes et les poils de peaux contre leurs attaques.*
Mémoires, 1728 (1730), p. 311–337.

(56) 1729 (1731) *Quelle est la principale cause de l'altération de la blancheur des pierres et des plâtres des bâtimens neufs?*
Mémoires, 1729 (1731), p. 185–193, 1 pl.; *Histoire*, p. 32–34 (*Sur l'altération de la couleur des pierres et des plâtres des bâtiments*).

(57) 1729 (1731) *Second mémoire sur la porcelaine; ou suite des principes qui doivent conduire dans la composition des porcelaines de différents genres; et qui établissent le caractère des matières fondantes qu'on peu choisir pour tenir lieu de celles qu'on y emploie à la Chine.*
Mémoires, 1729 (1731), p. 325–344.

(58) 1730 (1732) *De la mécanique avec laquelle diverses espèces de chenilles, et d'autres insectes, plient et roulent des feuilles de plantes et d'arbres, et surtout celles du chêne.*
Mémoires, 1730 (1732), p. 57–77, 4 pls.

(59) 1730 (1732) *De la nature de la terre en générale, et du caractère des différentes espèces de terres.*
Mémoires, 1730 (1732), p. 243–283; *Histoire*, p. 23–32 (*Sur la nature de la terre en génèrale et sur ses caractères*).

(60) 1730 (1732) *Regles pour construire des thermomètres dont les degrès soient comparables et qui donnent des idées d'un chaud ou d'un froid qui puissent être rapportés à des mesures connües.*
Mémoires, 1730 (1732), p. 452–507, 1 pl.; *Histoire*, p. 9–23 (*Sur une nouvelle construction de thermomètre*). German translation of this and subsequent papers on the thermometer in A. J. von Oettingen, *Abhandlungen über Thermometrie von Fahrenheit, Réaumur, Celsius (1724, 1730–1733, 1742)*, Leipzig, W. Engelmann, 1894, 17 figs.

(61) 1731 (1733) *Second mémoire sur la construction des thermomètres dont les degrès sont comparables, avec des expériences et des remarques sur quelques propriétés de l'air.*
Mémoires, 1731 (1733), p. 250–296; *Histoire*, p. 6–15 (*Sur le nouveau thermomètre*).

(62) 1733 (1735) *Essais sur le volume qui résulte de ceux de deux liqueurs mêlées ensemble; au sçavoir si deux liqueurs mêlées ensemble ont un volume égal à la somme de volumes qu'elles avoient prises séparément, ou si elles en ont un plus grand ou plus petit que la somme des deux premiers.*
Mémoires, 1733 (1735), p. 165–185; *Histoire*, p. 18–22 (*Sur le volume des liqueurs meslées*).

(63) 1733 (1735) *Observations du thermomètre faites par M. Cossigny, correspondant de l'Académie, à l'Isle de Bourbon, à l'Isle de France, à Madagascar, et dans la route depuis l'Orient jusqu'à ces isles, pendant l'année 1732, et partie de l'année 1733. Comparées avec les observations du thermomètre faites à Paris pendant le même temps.*
Mémoires, 1733 (1735), p. 417–438.

(64) 1733 *Generosi de Réaumur observatio de stellis marinis*, etc. in J. H. Linck, *De Stellis marinis liber singularis . . . figuras . . . et auctoris observationes disposuit et illustravit C. G. Fischer. Accedunt E. Luidii, De Réaumur et D. Kade hujus argumenti opuscula.* pp. *xxiv* + 107, 42 pls. fol. Lipsiæ, 1733.

(65) 1734 *Mémoires pour servir à l'histoire des insectes.* Vol. I, 654 pp., 50 pls. 4°, Paris, impr. Royale, 1734; *Précis* of same in *Histoire*, 1734 (1736), p. 18–38.

(66) 1734 (1736) *Expériences sur les différents degrès de froid qu'on peut produir en mêlant de la glace avec différents sels, ou avec d'autres matières, soit solides, soit liquides; et de divers usages utiles auxquels ces expériences peuvent servir.*
Mémoires, 1734 (1736), p. 167–195; *Histoire*, p.9–15 (*Sur les congélations artificielles*).

(67) 1734 (1736) *Suite des observations du thermomètre, faites à l'Isle de Bourbon par M. Cossigny, correspondant de l'Académie; et le résultat de celles de chaque mois, faites à Paris pendant l'année* 1734, *avec un thermomètre pareil à celui de M. Cossigny.*
Mémoires, 1734 (1736), p. 553–563.

(68) 1735 (1738) *Sur la manière de conserver les oeufs.*
Mémoires, 1735 (1738), p. 465–472.

(69) 1735 (1738) *Extrait d'une lettre de M. Bougeur, écrite du Petit Goave dans l'isle de Saint Domingue, le 26 Octobre 1735, sur la longueur du pendule.*
Mémoires, 1735 (1738), p. 522–544, 1 pl.

(70) 1735 (1738) *Observations du thermomètre faites à Paris pendant l'année MDCCXXXV comparées avec celles qui ont été faites sou la Ligne à l'Isle de France, à Alger, et en quelques-unes de nos isles de l'Amerique.*
Mémoires, 1735 (1738), p. 545–576.

(71) 1736 *Mémoires pour servir a l'histoire des insectes.* Vol. II, 1736, 514 pp., 40 pls. Paris, Impr. Royale. *Précis* of same in *Histoire*, 1736 (1739), p. 8–37.

(72) 1736 (1739) *Observations du thermomètre faites à Paris pendant l'année MDCCXXXVI comparées avec celles qui ont été faites pendant la même année dans différentes parties du monde.*
Mémoires, 1736 (1739), p. 469–502.

(73) 1737 (1740) *Sur les étincelles produites par le choc de l'acier contre un caillou.*
Mémoires, 1737 (1740), p. 391.

(74) 1737 *Mémoires pour servir à l'histoire des insectes.* Vol. III, 1737, 532 pp., 47 pls. Paris, Impr. Royale. *Précis* of same in *Histoire*, 1737 (1740), p. 9–36.

(75) 1737 (1740) *Observations du thermomètre faites à Paris pendant l'année MDCCXXXVII comparées avec celles qui ont été faites dans des climats très-différents de celui de Paris.*
Mémoires, 1737 (1740), p. 470–490.

(76) 1738 *Mémoires pour servir à l'histoire des insectes.* Vol. IV, 1738, 636 pp., 43 pls. Paris, Impr. Royale. *Précis* of same in *Histoire*, 1738 (1740), p. 16–36. The following seem to be translations of portions of this volume: J. A. von Goeze, *Von zweiflüglichten lebendig gebärenden Fliegen und von der besonderen Art, wie die jungen Würmchen im Mutterleibe liegen*, Neue Mannigfaltigkeit. 1775, 2, pp. 627–635, 641–650, 657–664, 673–679, 719–725, 1 pl.; *Epistola de cocco Polonico*, Mylius Physik. Belust.; Stück 10 p. 737; *Naauwkeurige verhandling over de bastaard Gall-Insecten van de Couchenille en van't gaals scharlaaken zaad, uit het fransh vertaald van den Herre Réaumur*, 8°, Amsterdam, 1767.

(77) 1738 (1740) *Observations du thermomètre pendant l'année MDCCXXXVIII, faites à Paris, à l'Isle de France, à Pondichery et au Senegal; et la comparaison de ces observations.*
Mémoires, 1738 (1740), p. 387–403.

(78) 1738 (1740) *Sur l'évaporation de la neige.*
Histoire, 1738 (1740), p. 36.

(79) 1739 (1741) *Observations du thermomètre pendant l'année MCCXXXIX, faites à Paris et en différens pays.*
Mémoires, 1739 (1741), p. 447–466.

(80) 1739 (1741) *Art de faire une nouvelle espèce de porcelaine par des moyens extrêmement simples et faciles, ou de transformer le verre en porcelaine. Premier mémoire. Où l'on examine la nature et les qualités de la nouvelle porcelaine, et où l'on donne une idée générale de la manière de la faire.*
Mémoires, 1739 (1741), p. 370–388.

(81) 1740 *Mémoires pour servir a l'histoire des insectes.* Vol. V, 1740, 728 pp., 38 pls. Paris, Impr. Royale. *Précis* in *Histoire*, 1740 (1742), p. 3–34. The following are translations of portions of this volume: "Natural History of Bees, containing an account of their reproduction, their economy, their manner of making honey, and the best methods for the improvement and preservation of them." 1744, 8°, pp. xvi + 452, 12 pls. London, Knapton; K. C. von Oelhafen und zu Schöllenbach, *Physikalisch-öconomische Geschichte der Bienen, worinnen von derselben Erzeugung, Vermehrung, rechten Warte und Pflege, Zucht und daher entstehenden vortrefflichen Nutzen in der Haushaltung, deutlich und vollständig gehandelt wird.* 1759, 4°, p. 6 + 406, 18 pls. Frankfurt u. Leipzig, Felsecker.

(82) 1740 (1742) *Observations du thermomètre faites en MDCCXL à Paris, et dans d'autres endroits, soit au Royaume, soit des pays étrangers.*
Mémoires, 1740 (1742), p. 539–566.

(83) 1741 (1744) *Insectes qui se multiplient sans accouplement et par la seule fécondité de chaque individu.*
Histoire, 1741 (1744), p. 32–33.

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INDEX

Aberto, 209
Acamatus antillarum, 250; *klugi*, 250
Addison, xvi
adelphogamy, 244
Adlerz, 38
Ælian, 132, 133, 142, 221, 223, 228, 230
Æsop, 229
Agassiz, 38
Albert the Great (Albertus Magnus), 160, 239
Aldrovandi, 26, 27, 131, 221, 227, 230, 239, 240, 241
Althaea rosea, 256
Amatus Lusitanicus, 258
amazons, 39
amber, 254
Amphioxus, 30
Ampulecid, 244
André, Ern, 225, 232
Anergates atratulus, 224
Ants, activities in artificial nests, 143, 144; adopting alien larvæ, 204, 205; agglutinating particles of earth, 215, 261, 262; aided in emerging from cocoons, 216; aiding one another, 194, 251, 252; "ants of visitation," 186-187; apartments in nests of, 141; Argentine ants in Canaries, 237; as food of young birds, 181, 247, 248; as physicians, 134; astronomical knowledge of ants, 222; attachment to formicaries, 191; attacking strange ants, 210, 262; attacking sugar-cane in Cayenne and Martinique, 156; attending Aphids and Coccids, 153, 154, 231, 232; battles of, 155, 232; behavior towards alien ants, 216; biting and stinging, 210; building bridges, 153, 232; caring for brood, 245; carnivorous habits, 157; carpenter ants of Montigny, 205-209; castes of, 241; colouration of ants, 135, 223; communication among, 194; copulation of, 211; cultivating fungi, 251; deälated females founding colonies, xvi, 245, 255, 257; deälated females laying eggs, 173-175; deälation of females and males, 162-164, 168-170, 171, 242, 243, 244; determination of migration, 251; devastations in West Indies, 232-239, 260; development of pupæ, 185; Doryline, 225; duration of larval and pupal life, 183, 249; earthworms as baits for, 157; eggs of, 173-176, 199, 246; escaping from cocoons, 185, 249; eulogies of, 133, 222; European, 135; excrement of, 200; experiment on feeding, 212, 213, 260; external form of, 160; fecundation of, 244; feeding and licking larvæ, 183, 248, 249; feeding on substances in soil, 239; feeding one another, 211; fertilization of eggs, 244; fondness for sweets, etc., 152, 156; foresight lacking in, 147; forming living bridges, 188, 251; founding colonies, 207; function of antennæ of, 240, 241; funerals of, 132, 222; galleries of, 142; gnawing radicles of seed, 149, 230; harvesting seeds, 148, 151, 230; hatred of dormice and cicadas, 134; hibernation of, 197; holidays of, 132; hours of repose of, 213; industry of, 131, 141, 194; injuring plants, 153, 154, 200, 256; kept from trees by chalk, 154; kitchen middens of, 222; larvæ covered with sticky moisture, 202-203, 247; larvæ fed through skin, (?) 204; larvæ of, 175, 179; larvæ spinning cocoons, 183-185, 249; larval hairs, 256; leaf-cutting ants of Surinam, 187-188; male genitalia of, 172, 211, 245; males do not work, 245; market days of, 221; Maori fable of ants and cicadas, 229, 230; marriage flight of, 164-168, 198, 199, 243, 255; methods of collecting pupæ, 181, 248; methods of destroying ants, xvi, 214; methods of keeping ants from sweets, 152; methods of transporting building materials, 191, 192; migrations of, 141, 225, 251; modesty of, 134; nesting in a teasel-head, 147, 182, 229; nesting in earth, 140, 201; nesting in hollow trees, 144, 145; nesting in masonry, 198, 254; nesting in meadows, 140; nesting in observation bee-

hives, 145, 146, 182, 229; nesting in wood, 139, 146, 207, 208; nesting under flower-pots, 140; obtaining food from soil, 159; odour of, 195; opening and closing nest-entrances, 210, 213, 258; oviposition, 246; prevision in, 134; preying on caterpillars, etc., 157, 158; preying on insect and spider eggs, 159; pupæ nude and enclosed in cocoons, 247; pupation of, 178, 179; removing brood, 179-182, 248; sedentary and migratory species, 135; severing cord to drop sugar, 201, 202; skeletons made by, 158; stinging ants, 259; summer and winter nests of, 254; transporting one another, 192-194, 251; unearthing larvæ by, 204, 256; use of by physicians and veterinarians, 196-197; varied occupations when disturbed, 191; wearing away pebbles, 252; wearing trails, 194-195; winged castes of, 161-162; workers as sterile females, 245
Aphids, 28, 231, 232, 243
d'Argenson, xiv, 15, 17, 18, 24, 232
Aristotle, 5, 30, 33, 260
Armadillidium, 253
Arture, 156, 232
Atta, 250
Audouin, 37

Balanoglossus, 30
Bazin, 243
Beebe, 249
bees, solitary, 239
beetles, 217, 262
Belt, 251
Best, 229
Bexon, 20
Blochmann, 246
Bodaert, xi
Bonnet, 6, 21, 38, 147, 182, 229, 231, 243, 251
Bontius, 209, 257
Bordage, 38
Bougainville, 24
Bouvier, xiii, 38
Bradley, 157, 239
Brisson, 12, 16
Brown, 236
Büsgen, 231
Buffon, 12, 14-25, 30, 31, 33

caddis-flies, 30
Calomyrmex, 223
Camponotus, 252, 257; *herculeanus*, 224, 256, 257; *ligniperda*, 205-209, 245, 256; *noveboracensis*, 256; *pennsylvanicus*, 256
de Candolle, 38
Cardano, 160, 163, 239, 240, 241, 243, 258
carriages, Réaumur's work on axles and bodies of, 9
Carter, 258
Carteria lacca, 257
carton, 228
castes, of ants, xvi, 241
Castles, 232, 235-238
Caullery, 20
Centaurea pratensis, 226
Cerceris buprestícida, 37; *ornata*, 37
Chalcoponera, 223
Chalicodoma muraria, 239
Chaubert, 262
Cheshire, 251
Chrysopids, 231
Clairaut, 14
classification, 26ff.
Cleanthes, 133, 222
Coccids, 231, 257
Coccinellids, 231
Coke, 232
colony formation, dependent, 247; independent, 247
Condillac, 18, 24, 33
Convers, xiii
Cook, 249
Cornetz, 251
de Cossigny, 170, 244
Couplée, xiv
Cowan, 222, 235, 248, 254
Craighead, 32
crocodile, 29, 30
cupia (see "termites")
Curculionids, 262
Cuvier, xi, xii, 6, 7, 14-17, 19, 21, 27, 252

D'Alembert, 14, 21, 24, 25
Dalla Torre, 236
Darcet, 8
Darwin, 5
Daubenton, 12, 15-17, 19-21
De Geer, xvi, xvii, 38, 225, 226, 231, 249, 255
demoiselles (see "dragonflies")
Dermatobia, 232
Descartes, 5, 19, 33
Diacamma, 244
Dickel, 247
Diderot, 25
digestion in birds, Réaumur's experiments on, 10, 12
Dipsacus fullonum, 229
Donisthorpe, 225, 246

Dorveaux, xiii
Dorylinæ, 244
Dorylus, 244, 250, 251
dragon-flies, 244
ductility of metals, Réaumur's study of, 7
Du Buysson, 38
Dufay, 25
Dufour, 28, 37, 38
Durand, 217, 262

earthworms, 36
Eciton, 225, 244, 250, 251; *burchelli*, 250; *hamatum*, 250
Edwards, 238
eggs of fowls; preservation and artificial incubation of, 9
Eidmann, 247
Elsholz (Elsholtius), 139, 226
Embiids, 262
Emery, 236
enzymes, 22
Epirrita dilutata, 239
Escherich, 39
Eugenius IV, 232
Eutermes, 261; *pilifrons*, 261
evolution, 29

Fabre, 4, 37, 38
Fabricius, 6, 27, 236
Ferton, 38
Fielding, xvi
fish scales, Réaumur's work on, 8
de Fleury, xiv, 153, 231
Flourens, xii, xiii, xv, 19, 32, 34, 36
Forbes, 231
Forel, 38, 225, 226, 228, 231, 254, 255, 258
Forelius, 223
formic acid, 195, 196, 210, 244, 252; in beer, 171; medicinal use of, 252, 254; prepared by distillation, 252; prepared by lixiviation, 252; prepared synthetically, 252; testing for in ant nests, 213
Formica, 228, 252; *caespitum*, 238; *exsecta*, 226; *foreli*, 226; *fusca*, 224, 247; *major*, 254; *minor*, 254; *omnivora*, 232-239; *pratensis*, xvi, 136-138, 189, 190, 199, 200, 211, 212, 225, 226, 239, 251, 252, 255, 256, 259, 260; *pressilabris*, 226; *rufa*, 138, 139, 209, 224-226, 239, 248, 252, 255, 257, 260; *saccharivora*, 232-239; *sanguinea*, 254
formicaries, covering surfaces of plants, 140; founded by migration, 186, 188-190; in hollow trees, 228; inundation and burning of, 191; limited growth of, 186; origin of, 177, 178; reparation of, 191
Formicoxenus nitidulus, 239
de Fouchy, 6, 12, 13, 19
Franklin, 25
Frederick the Great, 245
Fresneau, 214
von Frisch, 253
Fulton, 32
fungi, 36

Galilei, 5
Gauss, 245
Gehler, 221
generation, spontaneous, 36
genes, 21
George I, 260
Gesner, 260
Giard, 32, 38
glands of Nassonoff, 253
glass, Réaumur's work on, 8
Goldsmith, xvi
Gould, xvi, xvii, 230, 242, 245, 247-249, 260

Hagen, xi, 222, 226
von Haller, 6, 34
du Hamel, 239
Harvey, 5
Hatton, Mrs., 222
Haussard, xiv, 228
Hénault, 7
Herrera, 232, 235, 260
hollyhocks, 200, 256
honey-bees, 30, 35; castes of, 242; hexagonal cells of, 245; insalivation of eggs of, 247; observation hives of, 145, 228; odour of, 196, 252, 253; "speech" of, 253; swarming of, 177; swarms taking provisions from maternal hive, 251
Hooke, 5
Huber, F., 6, 38
Huber, P., xvii, 38, 39, 228, 231, 246, 258
Hughes, 238
Huxley, 5

"incense," Thuringian in ant nests; see resin, 138
industry, as a synonym of behaviour, 28, 33; revival of in France, 25
insects, intelligence of, 33; Réaumur's work on, 11
instincts, as feelings, 34; as chain-reflexes, 34; in honey-bees, 35; problem of, 32, 36; theory of, xii
Iridomyrmex, 223; *humilis*, 237

James, Wm., 37
Janet, C., 38
Jefferson, Thomas, 25
Jerome, St., 131, 221
Jonston, 139, 227, 243
de Jussieu, 20, 30

karabé, 253
Kentmannus, 139
Kirby and Spence, 230
König, 223, 245
Kutter, 39

Labat, 186, 250
Labidus prædator, 250
lac insects, 209, 257, 258
de Lacépède, 20
Lagrange, 245
Lamarck, 27
Lankester, 27
Lasius, 228, 252; (*Acanthomyops*) *claviger*, 255; *emarginatus*, 198, 199, 244, 254, 255; (*Dendrolasius*) *fuliginosus*, 144, 145, 220; *niger*, 224
Latreille, 6, 27, 28, 37, 229, 236
Lavoisier, 20
Leche, 231
Leeuwenhoek, 5, 210, 212, 246, 259
Leibnitz, 5, 20, 33
Lepeletier de St. Fargeau, 37
Leptothorax, 251; *emersoni*, 239; *tuberum*, 229
Lespès, 230
Lesser, 255, 261, 262
lestobiosis, 39
Leuckart, 232
Lichtenstein, 231
de Lignac, xii, 12, 15–19, 23, 34
Linnæus, xvi, 3, 6, 26, 27, 30, 31, 227, 232, 236, 238, 241, 242, 245, 260
Littré, 231, 250, 251, 254
Louis XV, xiv, 18, 24, 231, 245
Lubbock, 229, 231, 246
Ludot, 6, 21
Lyonet, xi, xiii, xvii, 6, 29, 200, 214, 228, 231, 239, 243, 249, 255, 261, 262

McCook, 246, 257
MacCurdy, Grace, 254
Macquer, 8
Macromischa, 223
Malchus, 221
Malebranche, 19
Malpighi, 5
Marcgraf, 209, 210, 257
Marchal, 37, 38
mastodon, 8
de Maupertuis, 171, 244, 245
Maury, 14-16, 20
Maxwell, Clerk, 245
Meinert, 228
Merian, Sibylla, 186-188, 250
Messor barbarus, 230; *structor*, 230
metallurgy, Réaumur's work in, 8
meteorology, Réaumur's work in, 9
Miall, xv, 6, 7, 14, 21-23, 30, 227, 243, 259, 261
Michelet, 4
de Mirepoix, 24
mites, 200
Moggridge, 230
du Monceau, 25
Monomorium, 237
de Montbeillard, 20
Montesquieu, 21
Mordwilko, 231
Moufet, 133, 212, 239, 241
Musset, 6, 16, 22, 24
Myers, 229
Myrmeleonids, 262
Myrmica lævinodis, 259; *omnivora*, 232; *rubra*, xvi, 165, 224, 243; *ruginodis*, 246; *scabrinodis*, 243

Nassau, Prince of, 257
Nassonoff, 253
Needham, 18, 22
nematodes, 36
Newton, 5, 9
Nylander, 226

Oniscus, 253
Oviedo y Valdez, 139, 227, 232, 260

pædogenesis, 243
Papilio machaon, 37
Paratrechina longicornis, 238, 239
parthenogenesis, 243
pearls, Réaumur on formation of, 8
Percheron, xi, 226
Pérez, J., 38
Peripatus, 30
Periplaneta americana, 250
petiole, 259
Pheidole indica, 230; *metallescens*, 223; *providens*, 230
Pholadidæ, 10
phototropism, 247
Picard, 38
Piccolomini, 232

Pictet, 38
Piron, 24
pismire, 223, 260
Piso, 209, 212, 257
Pistoriensis, Nicholas, 232
Pius II, 155
plant-lice (see "Aphids")
Pliny, 30, 31, 132, 195, 221, 222, 230, 252
Plutarch, 222, 230
poecilogony, 32
Pogonomyrmex, 230
de Pompadour, Madame, 15, 24
Ponerinæ, 244
porcelain, Réaumur's work on, 8
poudrier, 230, 231
Power, 212, 260
Pseudococcus, 238; *comstocki*, 237
Purchas, 235

Quérard, xii, 22

Rabaud, 26, 38
Raoul, 146, 147, 229
Ray, 5, 26, 31, 135, 211, 223, 252
Rayger, 209, 210, 257
Réaumur, as an engineer, 25; as founder of economic entomology, 26; as founder of ethology, 36; biography, 6 ff; character of, 12, 13; chirography, orthography, etc., xiv; compared with contemporary naturalists, 6; delay in completing *Mémoires* on the insects, 23 ff; his experimental methods, xvii; his letters, 6; his *Mémoires* on the insects, xi, 11, 23, 26; his opinion of Buffon, 21; his views on insect behaviour, 224-225; his work in taxidermy, 22; Huxley's estimate of, 5; influence on contemporaries and successors, 36 ff; list of writings, 263-274; manuscripts, xi, xii, 12; position in Academy of Sciences, 7, 14; style of, xv; supposed jealousy of Buffon, 12, 14 ff; taxonomy of Réaumur, 26, 224, 225; training, 7; versatility of, 7, 25
Redi, 5, 36, 255
Reimarus, 32, 33
resin ("incense") in formicaries, 213, 226, 227
Rhagium lineatum, 256
Riemann, 245
Reticulitermes lucifugus, 229
Rose, 170
von Rosenhof, Rösel, 29
Roubaud, 38
Roxburgh, 258
Rozier, 232, 244, 263

Santschi, 39
Saturnine, St., 235
de Saussure, 38
sawflies, 246
Schenck, 225
Schomburgk, 232, 235-237
Scullens, 138, 226
séchoirs, 252
Sée, 25, 247
Séguier, 6, 19, 22, 24
Seneca, 40
de Serati, 217
shells, Réaumur's work on fossil, 10
Silvius, Æneas, 155, 232
Sladen, 253
slaters, 196, 253
slave-makers, 39
Sloane, 214, 238, 260, 261
Smeathman, 223, 237, 238
Smith, Frederick, 222
Snodgrass, 253
snow, evaporation of, 9
Solenopsis geminata, 237, 239; *omnivora*, 237
Solomon, 230
Spallanzani, 6, 11
species, physiological, 32
spiders, 261, 262; aquatic 19; eggs on leaves, 214, 215; silk of, 9
spiracles, 211, 259
Stäger, 239
steel, Réaumur's work on, 8
stigmata (see "spiracles")
Stumper, 239
succinic acid, 254
Suetonius, 223
Swammerdam, xvi, 4, 5, 26, 27, 36, 161, 162, 164, 230, 241, 245, 248
Sykes, 230

Tabaraud, 19
Tapinoma melanocephalum, 238
Telliamed, 17
termites, 135, 146, 147, 223, 227, 229, 257, 261; deälation of, 170, 171, 209, 210, 212, 257; huge nests of, 139, 210, 214
du Tertre, 186, 212, 250
Tetramorium, 228; *caespitum*, 201-205, 256
thermometer, Réaumur's invention of, 8
tinplate, Réaumur's work on, 8
torsion of cords, Réaumur's study of, 7
Trembley, 6, 29, 243, 261
Troublet, 24

Turner, 232
turquoise, Réaumur's work on, 8

Vallisnieri, 5, 26, 27, 212, 259
Vermileo, 22
de Vertillac, Madame, 24
Virgil, 230
Voltaire, 25, 245

Wasmann, 225, 226, 232, 254
Wheeler, 232, 245, 256, 257
white ants (see "termites")
Whitehead, 245
Wilm, 33
worm-lion, 22
Wotton (Odoardus), 212, 259

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